

## Explanation in theories of the specious present

Valtteri Arstila <sup>a,b</sup>

<sup>a</sup>Department of Philosophy, University of Helsinki, Helsinki, Finland; <sup>b</sup>Department of Philosophy, University of Turku, Turku, Finland

### ABSTRACT

Time-consciousness theories aim to explain what our experiences must be like so that we can experience change, succession, and other temporally extended events (or at least why we believe we have such experiences). The most popular and influential explanations are versions of theories of the specious present, which maintain that what we experience appears to us as temporally extended. However, the role that specious presents have in bringing about temporal experiences remains undescribed. The briefly mentioned suggestions maintain that having temporally extended experiential content is either necessary or sufficient for having temporal experiences, or that the contents provide input for separate perceptual processes. In this paper, I argue that none of these suggestions succeed. Consequently, the theories of the specious present have not provided a satisfactory explanation of temporal experiences and their central motivation is lost.

### ARTICLE HISTORY

Received 15 September 2022

Accepted 21 July 2023

### KEYWORDS

Temporal experiences; specious present; perceptual processes

## 1. Introduction

In everyday life, we experience traffic lights changing and cars moving forward or honks from car horns succeeding, if the front car does not begin to move fast enough. These are stereotypical temporal experiences that time-consciousness theories aim to account for in some way. Most theories endorse *Phenomeno-Temporal (PT) realism*, a view that the temporal experiences are real experiences. Thus they maintain, for example, that we experience change and succession rather than merely judge that change or succession has occurred. Although there is a related temporal phenomenology, the central objective of these theories is not to explain why the experiences feel like they do – for instance, what it is like to experience change or “change quale” – but what our experiences must be like so that we can have temporal experiences in general. The alternative is to reject the

**CONTACT** Valtteri Arstila  [valtteri.arstila@helsinki.fi](mailto:valtteri.arstila@helsinki.fi)  Department of Philosophy, University of Helsinki, Helsinki 00014, Finland

© 2023 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

reality of temporal experiences and aim only to explain why we believe we have such experiences.

The most popular and influential versions of time-consciousness that endorse PT realism subscribe to the doctrine of the specious present. William James (1890, pp. 609–610), who popularized the doctrine, summarized the idea as follows:

In short, the practically cognized present is no knife-edge, but a saddle-back, with a certain breadth of its own on which we sit perched, and from which we look in two directions into time. . . . It is only as parts of this duration-block that the relation of succession of one end to the other is perceived. We do not first feel one end and then feel the other after it, and from the perception of the succession infer an interval of time between, but we seem to feel the interval of time as a whole, with its two ends embedded in it.

This quotation illustrates two aspects of the doctrine of the specious present. First, the experiential contents of a specious present, such as colors and sounds, appear to us as covering a temporally extended interval.<sup>1</sup> Thus, some experiential contents must appear to occupy different temporal locations. Nonetheless, these contents belong to a single episode of experiencing, and similarly to apparently synchronous contents, they are experienced together on a unified experiential whole (i.e., the specious present). Second, the doctrine concerns a cognized present, the “subjective now.” Concurring with James, who emphasizes perceptual states rather than cognitive states, this is thought of in terms of what is present in the context of a single episode of experiencing. It is “specious” because it appears to cover an interval, whereas the mathematical notion of the present does not. The estimations of the interval that the specious present covers vary from a few hundred milliseconds (Grush, 2007) and half a second to a second (Dainton, 2008b, Dainton, 2008a) to a few seconds (Pöppel, 2004). Based on theoretical considerations, James (1890) suggested it could cover even an interval of 12 seconds.

Obviously, these two aspects are closely related and the definition of the doctrine of the specious present tends to vary slightly, depending on which aspect is emphasized. For the purpose of this paper, I emphasize the first aspect and adopt the following working definition of the doctrine:

*The doctrine of the specious present:* The contents of a single episode of experiencing appear to us as temporally extended.

The theories that subscribe to the doctrine come in two classes: extensionalism and retentionalism. Extensionalism maintains that our experiences appear to be temporally extended (as the doctrine states) and have a duration that matches their apparent duration. Retentionalism, in turn, maintains that while a specious present appears to us as being temporally extended, objectively it takes place in an instant or short-lived moment. One

way to understand this difference between the classes is in terms of the distinction between content/vehicle properties, where the properties in question concern duration (and possibly also other temporal properties) properties of the content and vehicle. In extensionalism what we experience (i.e., content) and the state that underlies this experience (vehicle) match, whereas in retentionalism they come apart. Different notions of psychological moments, which are essentially maximal (integration) time frames used by mental processes, have been claimed to equate to the extensionalist or retentionalist concept of the specious present (e.g., Dorato & Wittmann, 2020, Singhal & Srinivasan, 2021).

The snapshot models reject the doctrine and maintain that the contents of a single episode of experiencing (i.e., a snapshot) do not appear as temporally extended. In prominent versions, objectively, they are short-lived though (Chuard, 2017, Le Poidevin, 2007). The snapshot models are often quickly denounced because historically the most notable version, the cinematic model (Chuard, 2017, Reid, 1850), maintains that snapshots are like static frames in films and subsequently rejects PT realism. Consequently, most philosophical time-consciousness theories are versions of the specious present theories, and the debate over time-consciousness has revolved around such theories (Dainton, 2017). Accordingly, the examination has focused on things that differentiate between theories of the specious present, not on the basic tenets they share. Thus the debated questions include, first, for example, in what sense the experiential contents are present in the specious present; second, as the succession of the specious presents is thought to form the stream of consciousness, what is the nature of such a stream in different theories?

Crucially, what has not received attention is the question of how exactly the notion of the specious present affords an explanation of temporal experiences. One can speculate that the reason for this shortcoming is that, for the most part, the answer to this issue would apply equally to extensionalism and retentionalism. Thus it would play no role when the pros and cons of different theories are under consideration. Nonetheless, the lack of explication of this issue is remarkable because very few argue for the doctrine independently of temporal phenomenology, and even those who are claimed to do so do, in fact, appeal to experiences of motion, succession, and so forth.<sup>2</sup> Indeed, it is the primary motivation for the doctrine in the first place, and one could say, only slightly exaggerating, that if there were no temporal experiences, there would not be specious present theorists.

This paper aims to address the described shortcoming and critically assess the role of a specious present in accounting for temporal experiences. It is concluded that the current explanation of temporal experiences is inadequate. I will begin by clarifying the central explananda of theories of the specious present (§2) and why it does not entail that the doctrine of the

specious present is correct (§3). Rather, having a specious present is supposedly a part of the explanation of the phenomena in question. Nonetheless, having a specious present is insufficient for having temporal experiences (§4). Instead, specious presents provide (raw) material for perceptual processes that result in temporal experiences (§5). This conclusion, in turn, leads to the problem of delayed temporal phenomenology, an introspectively implausible conclusion in which we experience change, succession, and so forth after experiencing the related experiential contents. In §6, I will argue that the most obvious responses to the problem of delayed dynamism are unsuccessful. As a result, we are left with the situation in which those who endorse the doctrine of the specious present have not adequately accounted for temporal experiences.

## 2. The explananda: core temporal experiences

The notion of temporal experience refers to a broad class of (purported) experiences. Common to all is that they relate to temporal properties or imply temporally extended phenomena. The central explananda of time-consciousness theories consist of the experiences of change, motion, and succession. While other temporal experiences figure in the discussions too, virtually all theories exemplify the idea of the specious present by appealing to some of the three “core” temporal experiences.<sup>3</sup>

It is furthermore worth emphasizing two features of specious present theorists’ views about these experiences. First, they insist that temporal phenomenology is something in addition to mere experiences at different times. For instance, as emphasized already by James and Husserl – and repeated in different forms several times later (see Hoerl, 2013) – an experience of succession is different than a (mere) succession of experiences, and an experience of change is different than (mere) change in experiences. For this reason, the experience of succession (and *inter alia* for other temporal experiences) “must be treated as an additional fact requiring its own special elucidation” (James, 1890, p. 629). Such an “additional ingredient,” the temporal phenomenology related to core temporal experiences, accompanies the related experiential contents. That is, we experience things changing, moving, and succeeding instead of experiencing the things and the temporal phenomenology separately. For example, the experience of movement accompanies the experience of the ball at different places at different times. Similarly, we experience *Re* succeeding *Do*, not that there is an experience of succession separate from the experience of (*Do* and) *Re*.

Second, specious present theorists maintain that (subjectively) the core temporal experiences are experiences on a par with other sensory experiences. To give some examples, when writing about experiences of motion, Broad (1923, p. 287) maintains that “I am aware of them [motion and rest]

as directly as I am aware of the redness of a red patch.” William James (1904, p. 536), in turn, holds the view that “the change itself is one of the things immediately experienced.” Finally, Bertrand Russell (2009, p. 93) argues that the temporal relation of one event being later than another “is as much given as the events” themselves, and Alfred Ayer (1957, p. 170) asserts that “as a matter of empirical fact, one can see or hear A-following-B, in the same immediate fashion as one can see A-to the left of-B.” In short, as these examples illustrate, there is a long tradition within philosophy to endorse PT realism and, moreover, to maintain that core temporal experiences are as real as experiences of, say, colors.

Arguably, the focus on core temporal experiences is not (only) because the reality of other temporal experiences is doubted, but because of what is required to account for different experiences. As mentioned above, specious presents embrace a limited interval. Consequently, only those experiences that are always short-lived enough – namely core temporal experiences – can be explained with the contents of a single specious present. Suppose, for example, that you hear a persisting sound for 20 seconds. In this case, the temporal experience concerns a phenomenon that lasts much longer than the interval the specious present covers. Hence, assuming that there is an experience of persistence, it cannot be explained by appealing to the contents of one specious present, but it rather involves several succeeding specious presents. Note also that since accounting for them requires an explanation in which not all parts of the experience are experienced together on a single unified episode of experiencing (whether it is a specious present or a snapshot), there is no reason why the snapshot models could not account for these experiences too, by appealing to the succeeding snapshots.<sup>4</sup>

It has recently been suggested that the experience of causality, the impression that there is a causal relationship between the cause and effect, should be added to the list of core temporal experiences (Arstila, 2018). This suggestion is well-motivated. For example, the reports of the experienced causality describe a dynamic event similar to the reports about change and motion: If a moving stimulus collides with a stationary stimulus and stops moving, and the stationary stimulus begins to move in the right direction, we report experiencing that an initially moving stimulus caused the stationary stimulus to move. Moreover, we experience causality only if the delay between the collision and the initiated movement is roughly less than 100 milliseconds, which is much shorter than the estimations for the temporal extension of the contents of the specious present (Straube & Chatterjee, 2010). Third, the reality and perceptual nature of the experience or impression of causality is generally well-received nowadays (e.g., Moors et al., 2017, Rolfs et al., 2013). Finally, related to the previous point, the experienced causality is not a matter of judged causality since the two can

come apart. On the one hand, we can make causal judgments without the impression of causality. On the other hand, subjects in psychophysical experiments report experiencing causality even though they are aware that the cause and effect are asynchronous or spatially separated, and hence that there is no causal relationship (Choi & Scholl, 2006, Schlottmann & Shanks, 1992).

In summary, the typical central explananda of time-consciousness theories consist of three core temporal experiences. Common to these three experiences is that they are short-lived enough to be explainable with the contents that a single specious present embraces and, possibly, cannot be explained without accepting the doctrine of the specious present. Moreover, there are sound reasons for adding the experience of causality to the list of core temporal experiences.<sup>5</sup> As it is similarly dynamic, perceptual, and as short-lived as the other experiences, in what follows, I will include it in the list of core temporal experiences that the specious present should be able to explain. (I do not believe that including it is crucial for my arguments, but it makes the argumentation more straightforward.)

### 3. The specious present is not logically necessary for temporal experiences

How should we understand the role of a specious present in us for having core temporal experiences? One option is to maintain that having a specious present is a necessary condition for having core temporal experiences. Concurring with such an assessment, Shaun Gallagher and Dan Zahavi (2008, p. 78), for example, insist that having an experience of succession is impossible if “the perception is reduced to the grasping of a mere now-point.” If this is true, then core temporal experiences entail the doctrine of the specious present.

The claim that the specious present is necessary in us for having temporal experiences can be understood in two different ways. First, although temporal experiences motivate the theory of the specious present that Gallagher and Zahavi endorse, their view concerns all experiences. The specious present describes the fundamental temporal structure of consciousness that is a necessary condition for all experiences, not merely for core temporal experiences. Hence, while this may be so, without further explication, the claim does not help us understand how we can have core temporal experiences. As my focus is on how the doctrine of the specious present supposedly affords us core temporal experiences rather than all experiences, nor do Gallagher and Zahavi provide an argument why the specious present would be logically necessary for the possibility of us having any experiences, I will not consider this more general issue here.

The second way of understanding the necessity of the specious present for core temporal experiences holds that there is something special about temporal experiences that necessitates having the specious present. Namely, it is reasoned that, because these experiences concern temporally extended events, we can have them only if the contents of temporal experiences are temporally extended too. For example, we must have an experience that somehow comprises both Do and Re in order to experience Re succeeding Do. One philosopher who appears to hold such a position is Rick Grush (2007, p. 3), who writes, “Since motion only manifests over a temporal interval, then on the assumption that we can perceive motion, it follows that the content of perceptual experience, what is experienced, must include a temporal interval.” According to this position, then, having a specious present is thought to play a role in the explanation of these experiences in the sense that if there were no such experiences, there would not be a need for the specious present, and the doctrine of the specious present directly follows when we take the nature of these experiences into account.

The claim that having a specious present is necessary for us to have only the core temporal experience is questionable, however. On the one hand, as discussed above, having a single specious present does not account for all temporal experiences. Hence, from having experiences that concern temporally extended events, it does not necessarily follow that the doctrine of the specious present is correct. On the other hand, core temporal experiences have been accounted for in some versions of *the snapshot model* (Arstila, 2016b, Arstila, 2018, Le Poidevin, 2007, Prosser, 2016). Like the cinematic model and unlike the theories of the specious present, these views maintain that the experiential contents are confined to objectively instantaneous or very short-lived snapshots. Unlike the cinematic model and like the theories of the specious present, these views endorse PT realism. Their explanation of temporal experiences maintains that we have had a succession of experiences over time—e.g., first an experience of Do and later of Re – but we do not need to experience these contents together to experience succession. Instead, say, hearing Do can have an unconscious effect on the experience of Re. Thus while having temporal experiences involves a temporal interval, a succession of experiences, it does not necessitate that we experience that whole interval in a single episode of experiencing.<sup>6</sup> As this is a real option – it remains an empirical matter whether this explanation is true or not – realism about core temporal experiences does not necessitate the doctrine of the specious present.

To sum up, the doctrine of the specious present does not follow by necessity from the possibility of having temporal experiences (at least not any more than the possibility of having experiences in the first place). Thus, if having a specious present is needed for such experiences, this must be

justified by explaining the role that the specious present plays in bringing about core temporal experiences. Merely stating that a specious present is necessary for these experiences is question-begging, for it does not explain this purported fact and reasons to accept it. Therefore, let us consider how the theories of specious present have been suggested to explain core temporal experiences.<sup>7</sup>

#### 4. Insufficiency of the specious present for temporal experiences

Consider the following situation. When I am typing this, I see the keyboard, monitor, and coffee cup. I experience these three things having specific spatial properties like shapes and sizes. I also seem to be immediately conscious of their specific locations and spatial organization. As I am typing, I see that the keyboard is closer to me than the monitor, and my coffee mug is between the two. Moreover, these spatial relations appear to be present in my experiences with equal effortlessness and the same immediacy as I see the colors and shapes of objects (and hear sounds and so forth). I do not need to (usually) infer them from other phenomenal cues, nor do I need memory for it. One possible explanation for why my perception of their spatial relation is immediate and direct is that the monitor, keyboard, and coffee mug, as they are experienced, are embedded in *the (visuo-)spatial field*. In this explanation, the experienced spatial relations (possibly other properties, too) are subordinate to the whole spatial field and do not need to be separately processed. Instead, the experienced spatial relations between the seen objects are *manifested* in the apparent layout of the spatial field, and once the locations of the objects are settled in it, there is no need for further explanation for their experienced spatial relations.

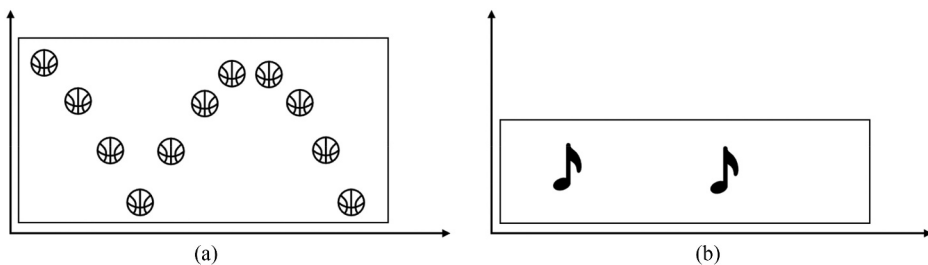
At the outset, the doctrine of the specious present affords a similar seemingly straightforward explanation for core temporal experiences. Recall, specious presents consist of experiential contents that appear for a subject to have occurred at different times. Thus, the contents can be said to be embedded in some sort of *temporal field* of the specious present. Just like the things we see have a location in the visual field, they have a location in the temporal field that the specious present embraces.<sup>8</sup> In both cases, all contents within the field are experienced together. It is as if we can apprehend the temporal field at one go, just like we can apprehend the spatial field at one go. Hence, if the previous story of our experiences of spatial relations is accepted, maybe similar reasoning holds for the experience of temporal features? Namely, experiential contents of a specious present appear to us as temporally extended, and to do so they must be temporally organized. Since the experiential contents (e.g., Do and Re) are already embedded in the temporal field, we can experience the temporal relations and features



holding between them with equal effortlessness and immediacy as the other experiential contents (and without additional processing).

This position concurs with Dainton's (2008b) and Phillips' (2014) view that temporal properties are manifestly present in our experiences, as well as Grush's comment above that "motion only manifests over a temporal interval". As an example, consider how Dainton explains the experience of motion when one sees a ball bouncing on a floor. This example is illustrated in [Figure 1a](#), adapted from Dainton (2017, figure 6). The horizontal axis refers to time as it appears to the subject and the vertical axis refers to the height at which things are perceived. The images of the ball depict what we experience: a ball at different heights (vertical axis) at a different time (horizontal axis). The ball appears to us as first being at some height, a little bit later lower in the air, then near the floor, hitting the floor, and then bouncing back into the air. The block represents a specious present and what is inside are the experiential contents that it embraces. True to the doctrine, the block is extended along the time axis, and the specious present appears to have temporally extended contents. As all contents within a specious present are experienced together, we experience the ball in all these different physical locations at different times within one specious present, and hence also how it moves during the interval that the specious present covers. Concurring, Dainton (2017) maintains that a specious present can "house continuous change, in the manner shown in [\[Figure 1a\]](#). Here we see a ball falling, bouncing and rising again, all within the confines of a single specious present." Because we apprehend all these positions at one specious present, we perceive the ball's motion with the same immediacy as we perceive its color and other surface properties.

The experience of succession is illustrated in [Figure 1b](#). This time the experiential contents include two sounds (say, knocks at the door), which again we experience within one specious present and as having occurred at different times. That is, the first knock is still experientially present and lingers in our consciousness as past or preceding content when we first experience the latter knock. Because we are conscious of both knocks during the same specious present, we



**Figure 1.** Contents of a specious present.

also experience the succession between them. Isn't the succession-relation that holds between the two experiential contents present or manifested within the specious present with the same immediacy as the contents themselves? This is how we can make sense of James' (1890, p. 610) claim that it is "as parts of this duration-block [i.e., specious present] that the relation of succession of one to the other is perceived."

The explanations we have just considered imply that having temporally extended experiential contents is sufficient for having core temporal experiences. Obviously, specious present theorists must explain how and why the contents of the specious present appear temporally structured, but once they provide such an explanation, no further explanation is needed for core temporal experiences. To experience motion and succession, we do not need anything over and above than to have a specious present that embraces the relevant experiential contents. We can call these contents *elementary experiential contents* as having them is not *prima facie* subject to other experiential states, whereas having temporal experiences are somehow dependent on them.

It is worth noting that the existing work on psychological moments amounts to the same explanation as philosophers have given. Namely, the literature on psychological moments describes their upper and lower temporal limits but does not provide any additional explanation for the mechanisms underlying temporal experiences. It is thus implied that once the existence of psychological moments is postulated, there is no further matter to be explained.

When we consider core temporal experiences in detail, we notice that the previous explanations cannot be the case, however. This is because the elementary experiential contents of two specious presents can have the same temporal structure (or even be the same), while only one includes a core temporal phenomenology. If there can be two specious presents whose experiential contents have the same temporal structure but differ as to a core temporal experience, then this difference must be accounted for in some other way than the temporal structure.

As a concrete example, let us return to [Figure 1b](#) and an experience of succession. Let us assume that we are presented with two brief stimuli with the interstimuli interval ("empty stimuli") of 50 milliseconds. If the stimuli are unimodal (e.g., auditory in [Figure 1b](#)) and presented at different locations, we are likely to experience succession (Hirsh & Sherrick, 1961, Sternberg & Knoll, 1973). If, however, the two belong to different sensory modalities (e.g., the latter sound is replaced with a flash), people report experiencing simultaneity, not succession (e.g., Van Eijk et al., 2008, Van Wassenhove et al., 2007). Given that the temporal structure of the experiential contents within a single specious present is the same, the structure

does not account for the differences in the presence and absence of temporal phenomenology between these two cases.

The same problem can be raised concerning the experienced causality. As mentioned above, people commonly report experiencing causality if an initially moving stimulus stops moving when it collides with a stationary stimulus, which in turn begins to move. This requires, however, that the motion in the right direction begins within 67 milliseconds after the collision. Suppose we tweak the setup by increasing the delay to 100–133 milliseconds or changing the direction of the latter movement to 45 degrees from the initial movement. In that case, the experienced causality is reported only about half a time (Straube & Chatterjee, 2010). These latter situations imply that the experienced causality is not a direct consequence of how things are laid out in the spatiotemporal field. After all, the spatiotemporal organization remains the same within both situations, but the presence of the experienced causality varies. Consequently, also this example suggests that temporal phenomenology cannot be accounted for solely by the temporal properties of experiential contents implicitly present in the specious present.

In short, having a specious present is not a sufficient condition for having core temporal experiences because it does not account for the difference between the presence and absence of core temporal experiences. One might respond to this objection by saying that although the objective properties of the stimuli remain the same, the spatiotemporal structure of the experiential contents varies, and it is the latter that determines whether succession or causality is experienced. While some such variation will most likely occur, this response is unsuccessful. This is because, in both examples, the events occur in a much shorter time than the interval specious presents are postulated to embrace, and one specious present covers all the relevant stimuli. Accordingly, contrary to the examples, if having the right apparent temporal structure among experiential contents would be all that matters for core temporal experiences, there should not have been variation in the experiences.

## 5. The specious present and the problem of delayed temporal phenomenology

How, then, can we explain the difference between the presence and absence of core temporal experiences in the examples above? What I want to suggest is that these differences are due to perceptual processes whose outcomes differ. One part of this explanation is that, just like color experiences are “outputs” of color perception (when the other necessary conditions are in place), motion experiences would be “outputs” of motion perception and change experiences of change perception (when the other necessary

conditions are in place). And likewise for other core temporal experiences. The second part is that, as with all perceptual processes, the ones related to core temporal experiences operate within certain limits and the cases above reflect the thresholds of those limits. As regards the example concerning experienced causality, tweaking the spatial (direction of the movement) and temporal (onset delay) features of the stimuli makes it closer to the spatio-temporal threshold of the perceptual processes related to causal perception. For this reason, a slight variation in the processing of the stimuli due to various factors other than stimuli (e.g., attention, neural noise) results in experienced causality and sometimes not. Succession perception, in turn, may operate or operate efficiently only based on unimodal stimuli. If this is the case, then it is only to be assumed that the impression of succession is absent or very weak for audiovisual stimuli that is presented in the specious present with a similar apparent temporal structure.

The explanation just described is not contentious if one adopts what Dainton has called *moderate naturalism*. It is a version of naturalism because it assumes “that our own capacities for experience are grounded in the neurological structures of our brains” (Dainton, 2008a, p. 313) and a moderate version because it does not assume any precise nature of the relationship between the experience and the structures. Concurring, he (Dainton, 2008b, p. 364) also refers to specific mechanisms – “perceptual sub-systems which specialize in the detection of motion” – when substantiating the claim that we have experiences of temporally extended events.

Dainton endorses moderate naturalism explicitly, and I take it that most of the current specious present theorists would agree with him. And if they do, then the latter part of the explanation follows almost by definition, as all perceptual processes operate within certain limits. Indeed, this part of the explanation also agrees with the views of specious present theorists, as they (e.g., Hoerl, 2013) explain the presence and absence of temporal experiences in terms of the limitations of the perceptual processes. Thus, Hoerl (2009, p. 11), for example, writes that the upper and lower limits of temporal experiences “reflect empirical, and empirically demonstrable, limitations of our perceptual systems, and are to be explained on the level of information-processing psychology.”

We can therefore explain the presence and absence of core temporal experiences in a way that is empirically sound and concurs with specious present theorists’ proposals. However, this explanation is something those snapshot model theorists who accept PT realism are likely to agree with since they have appealed to the findings of the respective cognitive neuroscientific studies supporting their position (e.g., Arstila, 2018, Prosser, 2016). Accordingly, the explanation is neutral between snapshot models and the theories of the specious present and does not explain the role of the specious present in us for having core temporal experiences.

If the two positions agree that core temporal experiences are grounded in the respective perceptual processes, but still give a (partly) different explanation for them, the explanation must reflect the difference between the two positions: The experiential contents of the episodes of experiencing (snapshot versus specious present) appear temporally extended only in the theories of the specious present. Hence, this difference purportedly accounts for the constitutive role of the specious presents in bringing about core temporal experiences – why the specious present is needed for core temporal experiences.

As mentioned before, the snapshot models only need to deny that the experiential contents of experiences appear to cover a temporally extended interval. Consequently, they deny us having phenomenal states related to Do when we hear Re – we do not experience Do and Re together – but they do not need to deny that we experience succession. The models differ in details, but according to their general explanation, we can come about having such an experience if the previously heard Do influences how Re is experienced, and this effect is mediated unconsciously or “non-experientially.” The nature of this effect depends partly on the contentious issue of how consciousness is understood. The perceptual process related to other core temporal experiences similarly operates based on unconscious and/or non-experiential information.

In contrast, the central part of the theories of the specious present is that the temporally extended experiential contents are needed for bringing about core temporal experiences. These theories hence maintain that having a specious present plays a constitutive role in us for having core temporal experiences. For example, my hearing of Do being present in my episode of experiencing and accompanying my hearing of Re grounds my experience of Re succeeding Do. If this were not the case, experiential contents could be confined to an instant, the earlier experiential contents could be causally effective in bringing about core temporal experiences, and having a specious present would not make a difference to core temporal experiences. To avoid such a conclusion and to provide an explanation that differs from the one provided by the snapshot models, the very reason for postulating the existence of the specious present leads to the claim that the apparently temporally extended experiential contents constitute the “data” for the perceptual processes that bring about core temporal experiences in the first place.

To summarize, I have argued that the difference between the presence and absence of core temporal experiences in identical experimental setups can be explained if the experiences are brought about by perceptual processes. The difference in having a specious present for these processes is that the perceptual processes utilize temporally extended elementary experiential contents – experiential contents within a temporal field of a specious

present – as input. As these processes concern core temporal experiences, having a specious present is (allegedly) needed for having such experiences but not for “typical” non-dynamic experiences (e.g., seeing a red apple). This conclusion explains why specious present theorists appeal to core temporal experiences, and not all experiences, when motivating the doctrine of the specious present.

Assuming that the provided account is correct – that is, core temporal experiences are grounded in processes that take elementary experiential contents within a specious present as their input – specious present theorists are led to another problem. I call it *the problem of delayed temporal phenomenology*: core temporal experiences occur after the experiential contents to which they relate have occurred, which in turn does not concur with the explananda.

This problem arises when we take into account the fact that, in the naturalistic framework, our experiences do not come about instantly (and magically) but result from processes that take time. For example, color perception processing begins when the light hits the retina and continues to go through a number of different processing stages before our color experiences occur. Estimations of how long this process takes depend on one’s view of the neural correlates of consciousness, but even in the shortest case, it takes roughly 150–200 milliseconds (Railo et al., 2011, 2015). Although the processes related to core temporal experiences could be faster, already for the reason that the input originates from the cortex and not the retina, they too take some time if they are grounded on neural processing.

However, there is a crucial difference between the processes related to color experiences and core temporal experiences: the nature of the data on which they are based. Color perception processes are not subject to other experiential states and result in elementary experiential contents.<sup>9</sup> Then again, as we have just discussed, the processes underlying core temporal experiences are grounded on elementary experiential contents (or their neural correlates). We have such experiences in virtue of having elementary experiential contents that belong to the same specious present and appear to have occurred at different times – the elementary experiential contents ground or are explanatory prior to core temporal experiences.

But this means that the processes related to core temporal experiences can fully commence only after we experience the relevant elementary experiential contents. That is, if such processes take the experiential contents of a specious present (or their neural correlates) as their “data,” they can proceed only after the relevant input informs them. As this processing takes time, the outcome of such processes must occur after the elementary experiential contents have occurred.

To make this problem more concrete, consider the experiences of S1 changing to S2 or S2 succeeding S1. If the explanation that specious present

theorists give to these examples is correct, the processes related to the experiences of change and succession can only begin after experiencing S2. Since such processes take some time, we experience change and succession only after we have experienced S2 and not at the same time. The temporal phenomenology of change and succession occurs after the change and succession have occurred.

The reason why this is a problem is that this does not concur with the explananda nor the introspective reports: if you are like me, you experience things moving, changing, and succeeding with each other. You do not first see an object at different places at different times and only later experience that it is moving (e.g., this could happen even after the object appears to stop changing its location). Nor do you first experience one thing, then another thing, and only later experience that the change has occurred. Or, you do not first hear Do and Re, and only later experience succession. In short, the claim that having a specious present plays a constitutive role in the perceptual processes related to core temporal experiences does not concur with the explananda and our introspective reports of these experiences.

## 6. Possible responses to the problem of delayed temporal phenomenology

The challenge specious present theorists must face is that, if (i) core temporal experiences result from perceptual processes specific to the experience in question, and (ii) such processes utilize the contents of the specious present, then (iii) we are led to an implausible description of our temporal phenomenology. This challenge can be addressed in several ways, but the most obvious ones are unsuccessful or otherwise difficult for the specious presentists to accept.

First, one could reject moderate naturalism regarding experiences, which underlies claim (i). In this case, experiences do not need to be brought about by processes that take time. Consequently, there is no reason why core temporal experiences could not take place simultaneously with the experiential contents they relate to. As discussed above, this option would be at odds with current specious present theorists. (One can still reject naturalism concerning the more contentious cases, such as intentional states and mathematical truths.)

Second, one could reject claim (ii), according to which the processes related to core temporal experiences were grounded on the elementary experiential contents. The option is based on the view that the specious present plays a role in accounting for why we have temporal experiences. It is the (purported) fact that our experiences appear to us as having temporally extended and structured experiential contents that we have core

temporal experiences. Because we have a specious present that embraces S1 and S2, and presents them as having occurred at different times, we can have the impression of change or succession. Hence, since claim (ii) results from the primary motivation to accept the doctrine of the specious present in the first place and the explanation of core temporal experiences that specious present theorists have provided, these theorists would need to provide a new justification for the doctrine and a new explanation of the core temporal experiences.<sup>10</sup>

The third way in which one might respond to the problem of the delayed temporal phenomenology is to accept the conclusion that there is a delay but maintain that it is so negligible that we do not notice it. This response, therefore, maintains that while there is a conflict between the conclusion and the introspective reports, this is not a problem because we should not take the reports as being entirely correct. The reports are correct regarding the experienced core temporal phenomenology and its causes but incorrect regarding the short temporal gap between the two because of the temporal resolution of our introspective mechanisms.

While it is reasonable to assume that our mental mechanisms operate with (varying) spatio-temporal resolution in the moderately naturalistic framework, this response is likely to be incorrect in the face of empirical evidence. On the one hand, cortical processing of core temporal experiences likely involves communication between different cortical areas, which in turn takes time. Pace visual motion processing, the processing related to core temporal experiences remains mostly unclear. As to visual motion processing, it is well-established that such processing receives input from the areas called V1 and V2, is dependent on the activity in V5 (“visual motion processing area”), and the experience of visual motion requires (at least) that the output of V5 processes is transmitted successfully back to V1/V2. Based on studies in which visual motion processing is disrupted, this cycle is likely to take at least 50 milliseconds (e.g., Koivisto et al., 2010, Silvanto et al., 2005).

On the other hand, our perceptual processes can have an excellent temporal resolution. For example, the shortest temporal difference in two flashes that can bring about an experience of (apparent) motion is between three to nine milliseconds (Sweet, 1953, Wehrhahn & Rapf, 1992, Westheimer & McKee, 1977). Similarly, at best, we can also determine the temporal order of two flashes separated by five milliseconds even without the impression of motion (for the typical 75% correctness rate) (Westheimer & McKee, 1977). Moreover, we can reliably detect gaps as short as five milliseconds in visual stimuli (Georgeson & Georgeson, 1985). For auditory stimuli, the shortest stimulus onset asynchrony we can detect is less than 20 milliseconds (Babkoff, 1975). We can also separate two pairs of auditory stimuli, in one of which a sound on the left ear is presented 1–2 milliseconds



before another sound is presented to the right ear and another pair in which the right sound precedes the left sound by 1–2 milliseconds (Efron, 1973).

In short, our perceptual processes can have an excellent temporal resolution, even if it is less precise under other conditions. As this resolution can be a magnitude smaller than the best estimations of the processing time related to visual motion processing, it is unlikely that we would not notice the estimated temporal gap between the experienced core temporal phenomenology and its causes.

Finally, one might appeal to Rick Grush's and Ian Phillips' views on temporal illusions. The general issue can be illustrated with the example of visual apparent motion: If two brief flashes (S1 and S2) are presented 100 milliseconds apart in different physical locations, people tend to report that there is one stimulus that moves between the two locations (for overview, see Arstila, 2016a). In other words, the movement between the locations of S1 and S2 is "filled-in." If S2 is not shown or the temporal gap between the two stimuli is much longer, we do not report experiencing motion. These illusions raise questions, such as: is the motion really experienced or merely reported? If movement is really experienced, how is it possible that we experience movement occurring before anything is seen at the location of S2? The challenge here is that the movement processing cannot begin before S2 is somehow registered (after all, the movement has a trajectory), and the idea that the experience of S2 is delayed so that the motion can be processed and experienced before S2 is empirically implausible. If movement is merely reported, how can we explain why we are so sure that we experienced movement (and can also distinguish them from situations where the motion is not experienced)?

Grush's (2007) explanation of this illusion is based on the idea that the experiential contents of the succeeding specious presents can be rewritten (i.e., they are independent of each other). Thus a specious present can include experiential contents related to S1 and the empty screen after it. In the succeeding specious present, the content is rewritten to represent motion too (i.e., the contents would relate to S1, movement, and S2). Applied to the problem of the delayed temporal phenomenology, one could then argue that there is a specious present that contains only elementary experiential contents (e.g., two sounds in succession). The next specious present would contain these same elementary experiential contents and, as occurring at the same time as them, temporal phenomenology of succession.

In this scenario, temporal phenomenology is either absent or experienced with the respective elementary experiential contents. As such, the problem of delayed temporal phenomenology does not arise. The solution also concurs with the earlier discussion on how having a specious present is insufficient for having core temporal experiences. Whether this is otherwise a plausible position is a matter of opinion. In my view, the position is

problematic for two reasons. First, its original explanation of the apparent motion is not empirically plausible (Arstila, 2016a), which puts the current explanation in doubt too. Second, because the experiential contents within the succeeding specious presents are independent of each other, the view implies the possibility of radical discontinuities between the succeeding specious presents – and yet this is not what we experience (Dainton, 2017).

Ian Phillips (2011) has argued, in relation to the postdiction effects such as apparent motion, that the specious present is metaphysically prior to its contents. For this reason, the questions about whether we experience the temporal gap between S1 and S2 or whether it is filled-in must be understood in the context of the whole specious present. This means that how the experiential content related to the empty screen is experienced can be influenced by the S2-related experiential content, although the latter is experienced after the former. Namely, when there is S2-related experiential content, in the context of the whole specious present, the earlier content related to the empty screen is experienced as having motion filled-in. If there is no S2-related experiential content, we only experience an empty screen. The benefit of this explanation is that there is supposedly no delay in perceiving S2 (we do not first need to register it and then delay seeing it so that the motion is filled-in). One might use a similar approach to respond to the problem of delayed temporal phenomenology. In this approach, one could say that the question of the timing of the temporal phenomenology is ill-posed, for it is the whole of the specious that matters: When the correct elementary experiential contents are present and have a suitable temporal location in the temporal field, then we also have temporal phenomenology.

This solution is unsatisfactory too, for two reasons. First, it is a variation of the view that having a specious present is sufficient for having core temporal experiences and leads to the same shortcomings. Namely, even if we accept that the whole of the specious present is prior to the experiential contents within it, one must account for the differences in which the contents have the same temporal structure, and yet the temporal phenomenology is present in only some cases. If such an account appeals to some processing, then the problem of delayed temporal phenomenology ensues; if some processing is not part of the explanation, then the experiences are not explained.

Second, Phillips' solution to the apparent motion phenomenon does not stand closer scrutiny. In particular, the questions regarding whether the filling-in takes place or not can also be asked when we consider succeeding specious presents. In particular, the described specious present is preceded by another specious present that includes experiential contents only related to S1 and the empty screen. We can hence also ask whether there was filling-

in within this specious present – and get the answer that there was not. That is, there is no filling-in in the specious present that does not yet include S2-related experiential content, but there is in the later specious present that includes it. Thus the subjects should provide two conflicting reports. Yet, this does not concur with the subjects' reports in the apparent motion experiments.

## 7. Summary

The received view holds that there are temporal experiences; we experience things moving, changing, succeeding, and causally impacting other things. These experiences provide the central motivation for the doctrine of the specious present. Since our experiences cover a temporally extended interval, we can also have experiences of temporally extended events such as change and succession. That is, specious presents purportedly play a constitutive role in bringing about core temporal experiences.

The role that specious presents have in bringing about temporal experiences remains insufficiently described, however. In this paper, I critically evaluated all three options that specious present theorists have presented. First, contra Gallagher, Grush, and Zahavi, I argued that the reality of temporal experiences does not entail the doctrine of the specious present (any more than other experiences might entail it). It may factually turn out that the doctrine of the specious present is correct and that being so (partly) explains our temporal experiences, but this is not necessarily the case because temporal experiences can, in principle, be explained also without accepting the doctrine. The second option is to hold that having a specious present is sufficient for core temporal experiences. According to this idea, core temporal experiences are (immediately) manifested by the temporal structure holding between the elementary experiential contents. However, this cannot be the case either because core temporal experiences can also be absent when the temporal structure is suitable for them. The third and final option explained why core temporal experiences are sometimes absent: they depend on the perceptual processes that bring about temporal experiences only in certain situations. In this alternative, the specious present is needed for the perceptual processes to commence. This option is unsuccessful too, however, for it leads to a phenomenologically implausible conclusion that we experience core temporal experiences after experiencing the elementary experiential contents on which they are grounded.

So, what does all this mean regarding the doctrine of the specious present? In my view, the key consequence is that it highlights how specious present theorists must (finally) begin to explicate the role that the specious present plays in us for having core temporal

experiences. They cannot simply assume that they are in a better position to explain the experiences than the snapshot models. This criticism, therefore, does not refute the doctrine of the specious present. After all, specious present theorists can come up with a new explanation or accept that there is a delay between temporal phenomenology and the elementary experiential contents that ground them. They could even maintain that the specious present does not account for temporal phenomenology (*per se*) and still subscribe to the doctrine if there are other reasons to do so. Nonetheless, without a sound explanation or new ways of motivating the doctrine, the argumentation puts the doctrine into doubt – especially if the snapshot models can provide a sound explanation of core temporal experiences.

## Notes

1. By experiential content, I mean the phenomenal features that are present in our experiences. These are also sometimes called experiential elements. An episode of experiencing consists of various experiential contents; we see cars in front of us having various colors and shapes, hear the sounds of motors, feel the wheel in our hands. Such experiential contents together determine what the (total) episode of experiencing feels like.
2. Shardlow (2020) has argued that there are two motivations for the doctrine of the specious present. The Sternian motivation is inspired by the aim of explaining temporal experiences. The Jamesian motivation, in turn, is motivated by the reflection that our experiences are temporally extended but limited. Although this latter motivation can be considered independent of the Sternian motivation, the basic datum – namely the phenomenology of temporally extended contents – is substantiated with an appeal to temporal experiences even by those who Shardlow takes to belong to this camp (e.g., William James, Ian Phillips, Matthew Soteriou).
3. Other experiences include, for example, the experience of simultaneity (Kelly, 2005), hearing a melody (Husserl, 1991), and the experience of duration (Dainton, 2008b).
4. Instead of there being succeeding specious presents, a less common view is to maintain that specious present changes continuously, with old experiential contents disappearing and new contents appearing within the specious present. One implementation of such a “moving window” view is Dainton’s (2008a, 2008a) overlap model of extensionalism. Although specious presents do not strictly speaking succeed each other in this view, the general point holds: a specious present embraces a limited interval and longer temporal experiences necessitate mechanisms that the snapshot theorists could appeal to. Dainton also maintains that only the overlap model of extensionalism can provide the introspectively accurate account of the continuity of the succeeding specious present. This assertion, which is equally against the snapshot models and other versions of theories of the specious present, may have a bearing on how to account for these longer temporal experiences. I will not address this question here, because the focus is on the core experiences, and many do not accept Dainton’s assertion (e.g., Gallagher, 2003, Grush, 2007).
5. In fact, the empirical case for the experiences (or impression) of causality is much stronger than it is for the experience of succession. A point worth noting here is that,

although there is a considerable amount of research on temporal order (succession) judgment, it is not directly relevant to the discussion at hand because the judgments do not necessitate the experience of succession. For example, in psychophysical studies, the judgments can be based on the order of (apparent) motion, dominant hue, or loudness cues. In everyday life, you are likely to be able to judge that you tasted your breakfast before lunch. None of these judgments involve an experience of succession.

6. It may be interesting to note that a concurring explanation has been given in visual motion processing in relation to direction-sensitive neurons and Reichardt motion detectors (Hassenstein & Reichardt, 1956).
7. Those who endorse snapshot models must explain how point-like or short-lived snapshots can account for temporally extended streams of consciousness, however. Since it is not evidently clear that they could not succeed in it, and addressing this issue is beyond the scope of this paper, different explanations are not elaborated on here.
8. The analogy between the (visuo-)spatial field that contains spatial relations (e.g., closer and next-to-one-another), on the one hand, and the temporal field of the specious present that contains temporal relations (e.g., earlier and later), on the other hand, was put forward early in the discussion related to time consciousness (see, for example, Husserl, 1991; Stern, 2005 [1897]).
9. Note that the claim concerns other experiential states, not unconscious non-experiential processes, as influencing color perception. Indeed, the processing related to the nearby objects and the whole visual field does influence how we perceive a certain object. However, there is robust evidence that central mechanisms, such as color constancy and color contrast processing, occur at least at the early (unconscious) stages of color perception processes (see, e.g., Conway, 2009, Teixeira et al., 2020). Since such unconscious influence is compatible with what the snapshot models have argued for, for the specious present theories to differ from them, the latter must hold that the core temporal experiences would be influenced by conscious or experiential states. I thank the reviewer for pressing me to make this point explicit.
10. A version of this response holds that the processing involves partly unconscious information. More precisely: the input for the processing consists of the earlier experiential contents that remain present in experiences and the unconscious information related to newer stimuli. This would allow the processing to commence and conclude earlier than if all input would consist of experiential contents. One of the shortcomings of this idea is that it does not require the doctrine of the specious present to be correct, for only the earlier contents are experientially present.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Funding

The research relates to the Mind and Matter profiling action, funded by the Academy of Finland. Separate funding from the Academy of Finland (grant number 342166)

## ORCID

Valtteri Arstila  <http://orcid.org/0000-0001-6838-9946>

## References

- Arstila, V. (2016a). Theories of apparent motion. *Phenomenology and the Cognitive Sciences*, 15(3), 337–358. <https://doi.org/10.1007/s11097-015-9418-y>
- Arstila, V. (2016b). The time of experience and the experience of time. In B. Mölder, V. Arstila, & P. Øhrstrøm (Eds.), *Philosophy and Psychology of Time* (pp. 163–186). Springer International Publishing. [https://doi.org/10.1007/978-3-319-22195-3\\_9](https://doi.org/10.1007/978-3-319-22195-3_9)
- Arstila, V. (2018). Temporal experiences without the specious present. *Australasian Journal of Philosophy*, 96(2), 287–302. <https://doi.org/10.1080/00048402.2017.1337211>
- Ayer, A. J. (1957). *The problem of knowledge*. Penguin Books.
- Babkoff, H. (1975). Dichotic temporal interactions: Fusion and temporal order. *Perception & Psychophysics*, 18(4), 267–272. <https://doi.org/10.3758/BF03199373>
- Broad, C. D. (1923). *Scientific Thought*. Harcourt, Brace & Company, Inc.
- Choi, H., & Scholl, B. J. (2006). Perceiving causality after the fact: Postdiction in the temporal dynamics of causal perception. *Perception*, 35(3), 385–399. <https://doi.org/10.1068/p5462>
- Chuard, P. (2017). The snapshot conception of temporal experiences. In I. Phillips (Ed.), *The Routledge handbook of philosophy of temporal experience* (pp. 121–132). Routledge. <https://doi.org/10.4324/9781315269641-10>
- Conway, B. R. (2009). Color vision, cones, and color-coding in the cortex. *The Neuroscientist*, 15(3), 274–290. <https://doi.org/10.1177/1073858408331369>
- Dainton, B. (2008a). *The phenomenal self* (p. 460). Oxford University Press.
- Dainton, B. (2008b). Sensing change. *Philosophical Issues*, 18(1), 362–384. <https://doi.org/10.1111/j.1533-6077.2008.00152.x>
- Dainton, B. (2017). Temporal consciousness. In *Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/entries/consciousness-temporal/>
- Dorato, M., & Wittmann, M. (2020). The phenomenology and cognitive neuroscience of experienced temporality. *Phenomenology and the Cognitive Sciences*, 19(4), 747–771. <https://doi.org/10.1007/s11097-019-09651-4>
- Efron, R. (1973). Conservation of temporal information by perceptual systems. *Perception & Psychophysics*, 14(3), 518–530. <https://doi.org/10.3758/BF03211193>
- Gallagher, S. (2003). Sync-ing in the stream of experience: Time-consciousness in Broad, Husserl, and Dainton. *Psyche*, 9, 10. <https://journalpsyche.org/files/0xaabb.pdf>
- Gallagher, S., & Zahavi, D. (2008). *The phenomenological mind*. Routledge. <https://doi.org/10.4324/9780203086599>
- Georgeson, M. A., & Georgeson, J. M. (1985). On seeing temporal gaps between gratings: A criterion problem for measurement of visible persistence. *Vision Research*, 25(11), 1729–1733. [https://doi.org/10.1016/0042-6989\(85\)90145-2](https://doi.org/10.1016/0042-6989(85)90145-2)
- Grush, R. (2007). Time and experience. In T. Müller (Ed.), *Philosophie der Zeit* (pp. 1–18). Klosterman.
- Hassenstein, B., & Reichardt, W. (1956). Systemtheoretische Analyse der Zeit-, Reihenfolgen- und Vorzeichenauswertung bei der Bewegungsperzeption des Rüsselkäfers *Chlorophanus* [System theoretical conception of the temporal, sequential and sign analysis in the perception of motion of *chlorophanus*]. *Zeitschrift Für Naturforschung B*, 11(9–10), 513–524. <https://doi.org/10.1515/znB-1956-9-1004>

- Hirsh, I. J., & Sherrick, C. E. J. (1961). Perceived order in different sense modalities. *Journal of Experimental Psychology*, 62(5), 423–432. <https://doi.org/10.1037/h0045283>
- Hoerl, C. (2009). Time and tense in perceptual experience. *Philosopher's Imprint*, 9(12), 1–18.
- Hoerl, C. (2013). A succession of feelings, in and of itself, is not a feeling of succession. *Mind*, 122(486), 373–417. <https://doi.org/10.1093/mind/fzt070>
- Husserl, E. (1991). *On the phenomenology of the consciousness of internal time (1893-1917)*. Kluwer Academic. <https://doi.org/10.1007/978-94-011-3718-8>
- James, W. (1890). *The principles of psychology*. <https://doi.org/10.1037/10538-000>
- James, W. (1904). A world of pure experience. *The Journal of Philosophy, Psychology and Scientific Methods*, 1(20), 533–543. <https://doi.org/10.2307/2011912>
- Kelly, S. D. (2005). The puzzle of temporal experience. In A. Brook & K. Akins (Eds.), *Cognition and the Brain: The Philosophy and Neuroscience Movement* (pp. 208–238). Cambridge University Press.
- Koivisto, M., Mäntylä, T., & Silvanto, J. (2010). The role of early visual cortex (V1/V2) in conscious and unconscious visual perception. *Neuroimage*, 51(2), 828–834. <https://doi.org/10.1016/j.neuroimage.2010.02.042>
- Le Poidevin, R. (2007). *The images of time: An essay on temporal representation*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199265893.001.0001>
- Moors, P., Wagemans, J., & De Wit, L. (2017). Causal events enter awareness faster than non-causal events. *PeerJ*, 5, e2932–e2932. <https://doi.org/10.7717/peerj.2932>
- Phillips, I. (2011). Perception and iconic memory: What Sperling doesn't show. *Mind & Language*, 26(4), 381–411. <https://doi.org/10.1111/j.1468-0017.2011.01422.x>
- Phillips, I. (2014). The temporal structure of experience. In V. Arstila & D. Lloyd (Eds.), *Subjective time: The philosophy, psychology, and neuroscience of temporality* (pp. 139–158). MIT press.
- Pöppel, E. (2004). Lost in time: A historical frame, elementary processing units and the 3-second window. *Acta Neurobiologiae Experimentalis*, 64(3), 295–301.
- Prosser. (2016). *Experiencing Time*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780198748946.001.0001>
- Railo, H., Koivisto, M., & Revonsuo, A. (2011). Tracking the processes behind conscious perception: A review of event-related potential correlates of visual consciousness. *Consciousness and Cognition*, 20(3), 972–983. <https://doi.org/10.1016/j.concog.2011.03.019>
- Railo, H., Revonsuo, A., & Koivisto, M. (2015). Behavioral and electrophysiological evidence for fast emergence of visual consciousness. *Neuroscience of Consciousness*, 2015(1). <https://doi.org/10.1093/nc/niv004>
- Reid, T. (1850). *Essays on the intellectual powers of man*. Cambridge: John Bartlett.
- Rolfs, M., Dambacher, M., & Cavanagh, P. (2013). Visual adaptation of the perception of causality. *Current Biology*, 23(3), 250–254. <https://doi.org/10.1016/j.cub.2012.12.017>
- Russell, B. (2009). *Our knowledge of the external world as a field for scientific method in philosophy*. Routledge.
- Schlottmann, A., & Shanks, D. (1992). Evidence for a distinction between judged and perceived causality. *The Quarterly Journal of Experimental Psychology*, 44A(2), 321–342. <https://doi.org/10.1080/02724989243000055>
- Shardlow, J. (2020). A tale of two Williams: James, Stern, and the specious present. *Philosophical Explorations*, 23(2), 79–94. <https://doi.org/10.1080/13869795.2020.1753803>
- Silvanto, J., Cowey, A., Lavie, N., & Walsh, V. (2005). Striate cortex (V1) activity gates awareness of motion. *Nature Neuroscience*, 8(2), 143–144. <https://doi.org/10.1038/nn1379>

- Singhal, I., & Srinivasan, N. (2021). Time and time again: A multi-scale hierarchical framework for time-consciousness and timing of cognition. *Neuroscience of Consciousness*, 2021(2). <https://doi.org/10.1093/nc/niab020>
- Stern, L. W. (2005). Mental Presence-Time [Psychische Präsenzzeit. In B. C. Hopkins, S. G. Crowell, & N. D. Warren (Eds.), *The new yearbook for phenomenology and phenomenological philosophy* (pp. 310–351). Routledge.
- Sternberg, S., & Knoll, R. L. (1973). The perception of temporal order: Fundamental issues and a general model. In S. Kornblum (Ed.), *Attention and performance IV* (pp. 629–685). Academic Press.
- Straube, B., & Chatterjee, A. (2010). Space and time in perceptual causality. *Frontiers in Human Neuroscience*, 4(April), 28–28. <https://doi.org/10.3389/fnhum.2010.00028>
- Sweet, A. L. (1953). Temporal discrimination by the human eye. *The American Journal of Psychology*, 66(2), 185–198. <https://doi.org/10.2307/1418725>
- Teixeira, M., Nascimento, S., Almeida, V., Simões, M., Amaral, C., & Castelo-Branco, M. (2020). The conscious experience of color constancy and neural responses to subliminal deviations – a behavioral and EEG/ERP oddball study. *Consciousness and Cognition*, 84, 102987. <https://doi.org/10.1016/j.concog.2020.102987>
- Van Eijk, R. L. J., Kohlrausch, A., Juola, J. F., & Van De Par, S. (2008). Audiovisual synchrony and temporal order judgments: Effects of experimental method and stimulus type. *Perception & Psychophysics*, 70(6), 955–968. <https://doi.org/10.3758/PP.70.6.955>
- Van Wassenhove, V., Grant, K. W., & Poeppel, D. (2007). Temporal window of integration in auditory-visual speech perception. *Neuropsychologia*, 45(3), 598–607. <https://doi.org/10.1016/j.neuropsychologia.2006.01.001>
- Wehrhahn, C., & Rapf, D. (1992). ON- and OFF-pathways form separate neural substrates for motion perception: Psychophysical evidence. *Journal of Neuroscience*, 12(6), 2247–2250. <https://doi.org/10.1523/JNEUROSCI.12-06-02247.1992>
- Westheimer, G., & McKee, S. P. (1977). Perception of temporal order in adjacent visual stimuli. *Vision Research*, 17(8), 887–892. [https://doi.org/10.1016/0042-6989\(77\)90062-1](https://doi.org/10.1016/0042-6989(77)90062-1)