

Silencing the experience of change

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Abstract Perceptual illusions have often served as an important tool in the study of perceptual experience. In this paper I argue that a recently discovered set of visual illusions sheds new light on the nature of time consciousness. I suggest the study of these silencing illusions as a tool kit for any philosopher interested in the experience of time and show how to better understand time consciousness by combining detailed empirical investigations with a detailed philosophical analysis. In addition, and more specifically, I argue against an initially plausible range of views that assume a close match between the temporal content of visual experience and the temporal layout of experience itself. Against such a widely held structural matching thesis I argue that which temporal changes we are experiencing bears no close relation to how our experience itself is changing over time. Explanations of the silencing illusions that are compatible with the structural matching thesis fail.

Keywords Temporal consciousness · Change blindness · Perceptual illusion · Attention

1 Introduction

Perceptual illusions have often served as an important tool in the study of perceptual experience.¹ In this paper I will argue that a set of visual illusions recently discovered by Suchow and Alvarez (2011a, b) sheds new light on the nature of time

¹ For example: the persistence of the *Müller-Lyer Illusion* (and others) has been claimed to bear on perceptual encapsulation (Fodor 1983); the *Ebbinghaus Illusion* and its (apparent) failure to influence perceptually guided action has been suggested to speak in favor of two separate visual pathways (Goodale

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consciousness. My general goal is to suggest the study of these *silencing illusions* as a tool kit for any philosopher interested in the experience of time. I will show how to better understand time consciousness by combining Suchow's and Alvarez' detailed empirical investigations with a detailed philosophical analysis.² In addition to this general goal, I will argue specifically against an initially plausible range of views that assume a close match between the temporal content of visual experience and the temporal layout of experience itself. Against such a widely held *structural matching thesis* I argue that which temporal changes we are experiencing bears no close relation to how our experience itself is changing over time. Explanations of the silencing illusions that are compatible with the structural matching thesis fail. I will end with brief suggestions for alternative models of time consciousness.

2 The structural matching thesis

Let us start with the phenomenon in question: visual experiences as of temporal properties. I will mostly concentrate on the experience of change. It seems that we see clouds and other object as moving (a change in location), as changing shape, or as changing color. C.D. Broad famously said:

[I]t is a notorious fact that we do not merely notice that something has moved or otherwise changed; we also often see something moving or changing. (Broad 1923, p. 351)

What makes the experience of temporal properties like change special and philosophically interesting? At least one fact that makes it special is that our experience not only *represents* temporal properties, but also *has* temporal properties (see e.g. Dainton 2000; Lee 2008; Phillips 2009 and Chuard 2011). For example, not only do you experience changes but your experience itself is also changing over time. Your experience is, as William James famously said, a temporally changing "stream of consciousness". The same does not seem true for any other properties you are experiencing. For example, while your experience represents colors or shapes, your experience is not itself colored or shaped.

The question arises how the temporal content of experience relates to the temporal layout of experience itself. It is extremely tempting to think that there is a direct match between them. One might, for example, think that the following claims are obviously true:

Footnote 1 continued

and Milner 1992); and the *Waterfall Illusion* has been suggested to entail that the content of perceptual experience must be non-conceptual (Crane 1988).

² My paper thus responds to a challenge to an empirical investigation of time consciousness once raised by Kelly (2005, p. 230) who said that "[t]here is a simple reason why no empirical work is being done on [the puzzle of temporal experience]. The reason is that we're not yet clear enough on what kind of work would make progress." My response proceeds by *showing* how philosophical analysis and empirical investigation can collaborate to make such progress (even though, of course, no single paper could claim to solve *all puzzles* about temporal experience).

- (i) You experience one flash of light as *occurring simultaneously* with a second flash of light *just in case* your experience of the first flash itself *is simultaneous with* the experience of the second flash.
- (ii) You experience one flash of light as *preceding* another flash of light *just in case* your experience of the first flash itself *precedes* your experience of the second flash.
- (iii) You experience one flash of light as *lasting longer than* another flash *just in case* your experience of the first flash itself *lasts longer than* your experience of the second flash.
- (iv) You experience a *fast change* in color *just in case* your color experience itself *is quickly changing*.

A variety of authors thus have suggested versions of the following straightforward relationship between the temporal content and the temporal layout of experience (see Mellor 1985; Foster 1991; Dainton 2000, 2008; Phillips 2008, 2009, forthcoming; Hoerl 2009).³

The Structural Matching Thesis There is a close match between the temporal structure of the content of experience and the temporal structure of experience itself.⁴

For someone who accepts the structural matching thesis claims (i)–(iv) are specific implications of that general idea: if you are experiencing color change, for example, the rate of change you are experiencing closely matches the rate at which your experience itself is changing. You will experience a fast (or slow) change in color just in case your color experience is changing at a similarly fast (or slow) rate.

The structural matching thesis only states a close correspondence. In addition, many proponents of the structural matching thesis also hold one of two *theses*. First, there is a layout-to-content thesis, according to which experience represents a certain temporal content *in virtue of* having a certain temporal structure. Second, there is an opposing content-to-layout explanatory thesis according to which experience has a certain temporal structure *in virtue of* having a certain temporal content.

³ See what Miller (1984) has called the principle of presentational concurrence PPC (endorsed by Foster 1991; Dainton 2000, 2008, 2010 and Phillips 2008, 2009, forthcoming): “the time interval occupied by a content which is before the mind is the same time interval which is occupied by the act of presenting that very content before the mind” (Miller 1984, p. 107), and also Foster (1991, p. 249): “We have to take experience to extend over a period of real time in a way which exactly matches the phenomenal period it presents”. There is also Dainton (2000, p. 180): “the overlap theory [Dainton’s view of time consciousness, see below] embraces PPC. So even if we draw an awareness-content distinction [which Dainton in the end does not] it makes no sense to suppose that an act of awareness can apprehend a content of a greater temporal duration than itself.” Hoerl’s (2009) “molecularist” (p. 2) reading of the specious present might be understood as endorsing a similar connection (though the issue here is not entirely clear). He says, for example, that his view is one on which “temporal experience is itself a temporally extended process, and there is an explanatory connection between the temporal structure of experience itself and its phenomenology as experience, e.g., as a succession of events.” (Hoerl 2009, p. 2).

⁴ My formulation is closely modeled on one in Philips (forthcoming). The idea of a “close match” is supposed to allow for some leeway. My argument against the structural matching thesis will work even if it is read as requiring only that the temporal structure of the content of experience and the temporal structure of experience itself be very similar, and not as the stronger thesis that the two be identical.

After noting what it says, let us look a little closer at why the structural matching thesis is so appealing and how it fits into the overall debate about time consciousness (in the course of discussing its motivations we will also encounter the explanatory variants of the structural matching thesis).

As a *first motivation*, there is simplicity. Since the structural matching thesis provides the simplest account of how the temporal content of experience is related to its temporal layout one might take it as the starting point that should be given up only if there is clear evidence against it (see Phillips forthcoming).

For a *second motivation*, suppose that you start by thinking about experience according to a “snapshot model” (discussed in Lee 2008) on which the stream of experiences consists in a series of momentary snapshots each being an experience only of what occurs at a particular time.⁵ So, if we were to fix a temporal series of such a-temporal snapshots the phenomenal character of the whole experience that has these snapshots as temporal parts would be fixed as well. So, if there is any experience as of temporal properties (i.e. if anti-realism about time consciousness is to be avoided), it must somehow be reduced to the temporal properties of the stream.⁶

The crucial idea here is that momentary snapshots cannot themselves represent temporal properties like change. It is plausible to call this a “cinematic” way of thinking of time consciousness (Lee 2007, 2008). Time consciousness here represents temporal properties in the way movies do. No single frame in a movie represents a change. Changes are represented by putting together a series of different frames. So we get the idea that temporally extended experiences (like an extended period of a movie) represent changes in virtue of the fact that they themselves are changing. What we might call *the simple cinematic view* of time consciousness (Dainton 2010) thus leads to the structural matching thesis (as well as to the layout-to-content explanatory thesis).⁷

According to the simple cinematic view there is nothing more to the experience of temporal properties than to have a succession of a-temporal snapshots. For this reason, many philosophers find the simple cinematic model unsatisfactory. Dissatisfaction with it often starts by referencing the following quote from William James:

“succession of feelings, in and of itself, is not a feeling of succession. And since, to our successive feelings, a feeling of their own succession is added, that must be treated as an additional fact requiring its own special elucidation[.]” (James 1890/1981, p. 628f).

⁵ That is: these snapshots are experiences as of non-temporal properties.

⁶ It is an assumption of the structural matching thesis that anti-realism is false. In order to keep the discussion focused, I won’t, thus, for the main part of this paper discuss anti-realism about time consciousness. See Fns. 37 and 41, though.

⁷ A quick note on terminology: Lee (2007, 2008) uses the notion of a “cinematic” picture broadly so as to include, for example, Dainton’s view of time consciousness. Dainton, by contrast, obviously has a more specific cinematic view in mind when he criticizes such views. The same confusion arises for the notion of a “specious present” view. Dainton uses this term to designate almost any *realist* view of time consciousness (including retentionist views and his extensional model). Tye (2003) and Lee (2008), by contrast, use the term in a more specific way, which excludes Dainton’s view. For reasons of terminological clarity I have therefore mostly avoided talk of the specious present in this paper.

As those who follow William James like to point out, for example, you don't have an experience as of one flash preceding another flash when your experience of the first flash precedes the experience of the second flash by *two hours*. So (the reasoning goes), there must be something more than succession of experiences to the experience of succession.

Suppose that we thus reject the *simple* cinematic picture. As long as one is attracted to the *general* cinematic thinking that rules out the experience of temporal properties at a moment, the Jamesian "additional fact" would somehow need to concern how experiences that are close enough in time are related to each other. Barry Dainton (2000, 2008), thus, holds that experiences that are close in time are co-conscious, i.e. they are phenomenally unified so that they compose a larger phenomenal whole (by contrast, experiences that are two hours apart do not compose such a whole). Temporal properties like change then are represented by such phenomenally unified, temporally extended and overlapping wholes (Dainton calls this the *extensionalist* view of time consciousness).

Like the simple cinematic view, though, the extensionalist view seems to be committed to the structural matching thesis (Dainton 2000): experiences *represent* temporal properties just in case (and probably because) they are phenomenally unified *and have those temporal properties*. For example, a unified whole represents succession just in case (and probably because) it contains succeeding (and partially overlapping) whole experiences; it represents change just in case (and probably because) it contains distinct (but partially overlapping) whole experiences; etc. We thus again seem to get both the structural matching thesis as well as the layout-to-content explanatory thesis.

A *third motivation* for the structural matching thesis appeals to the transparency of experience (Phillips 2008, 2009). The motivation idea here is this.

The way we go about trying to answer the question concerning the temporal structure of our conscious experience is by making a judgement about the temporal structure of the apparent objects of consciousness [...], *and then by taking our experience to be structured in the same way*. (Phillips 2009, p. 57)

On the basis of this idea Phillips argues that there isn't anything more to the temporal properties of experience than the temporal properties represented by experience.⁸ He endorses a "naïve view of temporal awareness" (op. cit, p. 93) where in veridical perception "[t]he temporal structure of experience is quite simply directly inherited from the temporal structure of the world" (p. 93), and in illusion "the temporal structure of experience matches the *apparent* temporal structure of

⁸ To be more precise, Phillips argues that this view follows from the acceptance of four principles (op. cit, p. 94): Realism, Temporal Transparency, Self-Intimation, and Seems → Is. The discussion of the present paper can be read as an extended argument against his Self-Intimation principle that says that (op. cit., p. 94) "[i]f a subject is undergoing perceptual experience of a certain experiential kind, then that subject is in a position to know that they are undergoing perceptual experience of that experiential kind simply in virtue of so undergoing." Scientific evidence like the one this paper appeals to might strongly support the claim that our experience has certain temporal properties that we were not in a very good position to know about simply in virtue of undergoing this experience. With the help of this evidence we can get a grip on the temporal structure of experience indirectly, and not via considering the content that experience represents.

the world.” (p. 94). Temporal content and temporal layout thus have to match, and we get the structural matching thesis again (in addition, and in contrast to the cinematic motivation, we also get the *content-to-layout* explanatory thesis).

Despite these motivations, the structural matching thesis has not been without challenges.

First, some have argued that it rests on a content/vehicle confusion (Dennett and Kinsbourne 1992). Consider the analogy of color experience. It would seem crazy to think that the color properties represented by experience must match the color properties of experience itself. By analogy, isn't it similarly crazy to think that the temporal properties represented by experience must match the temporal properties of experience itself? Yet, in response the proponent of the structural matching thesis will point out that experience does *not* have color properties while it *does* have temporal properties and so there is no analogy (see Lee 2008, and Phillips 2009).

Second, it has been argued that the structural matching thesis does not fit with what we know about how time is actually represented in the brain (Lee 2008, see also Eagleman et al. 2005). Yet, in response a proponent of the thesis might in various ways reject a close match between the temporal structure of experience and the temporal structure of the brain processes that enable experience.

Third, there have been counterexamples, which in some way are similar to the one I am going to present here. Lee (2008), for example, discusses illusions of duration (as well as illusions of simultaneity, and temporal order). For example, consider experiments where subjects are presented with one oddball stimulus in a series of identical stimuli. Though all of the stimuli in fact last the same amount of time, the oddball stimulus is experienced as lasting longer.⁹ At the same time, it might seem that your experience of the oddball must last the same amount of time as your experience of the other stimuli (otherwise your experience would soon lag way behind the stimulus). And so there is a mismatch between temporal content and the temporal structure of experience. Yet, proponents of the structural matching thesis have challenged this interpretation of the oddball effect and other such effects. Phillips (2009), for example, argues that in the oddball experiment subjects are simply making a mistaken comparative judgment about which stimulus lasted longer *afterwards*, and these “judgments concerning metrical durations will be not grounded in temporal aspects of experience.” (Phillips 2009, p. 116).¹⁰

Given the present state of the debate about the structural matching thesis with arguments on both sides, my goal in what follows will be to provide a detailed analysis of a new illusion of time consciousness (Suchow and Alvarez 2011a), show how it provides a counterexample to the structural matching thesis, and argue in detail that there is no plausible account of these illusions available to a proponent of that thesis. I will proceed by combining empirical results by Suchow and Alvarez (2011a, b) with philosophical analysis. Against the first motivation for the structural matching thesis I will argue that there is evidence against it (even if it were the starting point). Against

⁹ For various versions of this result see: Rose and Summers (1995), Tse et al. (2004), Ulrich et al. (2006), Pariyadath and Eagleman (2007), Xuan et al. (2007), and New and Scholl (2009). For a review see Eagleman (2008).

¹⁰ This is because, on Phillips view, experience does not represent metrical durations at all.

the second motivation, the illusions will show how the cinematic way of thinking (while intuitive) is misguided. Against the third motivation I will argue that Suchow's and Alvarez' studies show how to get a grip on the temporal layout of experience without directly considering its temporal content. I will end with alternative accounts of time consciousness (such as versions of the specious present view or retentionist views) and discuss how they can deal with these illusions.

3 The illusion

The set of illusions that Suchow and Alvarez have discovered can be watched online at: <http://visionlab.harvard.edu/silencing/>.

Subjects are presented with a display consisting of 100 colored dots arranged in the form of a ring around a central fixation mark. Each of these dots is constantly, rapidly and fairly continuously changing in one salient visual quality (either hue, luminance, size or shape). Subjects are instructed to maintain fixation at the central mark while paying attention to all the dots. In what follows I will focus on the hue experiment and speak of color changing dots.

In this experiment each dot is changing smoothly from red to orange to yellow etc., all the way through the color wheel, and back (the changes between the different dots are not synchronized).¹¹ The change in color can be represented by how fast one moves around the color wheel. Suchow and Alvarez call this “the rate of change” in color (we might also call it “color speed”, since it picks out the distance on the color wheel covered per unit time; it is measured in degrees per second).

The ring of dots now alternates between the following two conditions which each lasts the same amount of time and in each of which the dots are changing color in exactly the same way.¹²

The Stationary Condition The ring of color changing dots is stationary.

The Rotation Condition The whole ring of color changing dots is rotating back and forth around its center (at a speed that is varied between experimental conditions).

The illusion now consists in the following. While you can clearly see fast color changes in the stationary condition, the changes of color perceptually appear to be much slower in the rotation condition (while—of course—the dots in fact are changing color at exactly the same rate). In a certain local sense, you seem to experience that “time is slowing down” (local, because only changes in *color*—and not location—are experienced as slower). Suchow and Alvarez have quantified this effect by letting subjects manually adjust the color speed (their “rate of change”) during the stationary condition so as to match the way they experience the changes

¹¹ In the luminance condition the dots change smoothly from bright to dark, in the size condition they change their size, in the shape condition their shape smoothly morphs from (roughly) a star shape to a (roughly) round shape. For a precise description of the relevant parameters see Suchow and Alvarez (pp. 3–4). Everything I say applies *mutatis mutandis* to the illusions of changes of luminance, size and shape as well.

¹² The conditions last longer than one cycle around the color wheel.

in the rotation condition. The color changes in the rotation condition are found to visually look like the color changes in a slowed down version of the stationary condition. More precisely, the color changes in the rotation condition are found to phenomenally match color changes in the stationary condition that are two to ten times slower than the actual color changes in the rotation condition (Suchow and Alvarez call this the “silencing factor”). We thus have a graded phenomenon. The faster the rotation, the slower the dots seem to change color. When the rotation is fast enough the changes visually appear almost to stop.¹³

4 The structural matching thesis rejected

The dots on the screen are changing color in the same way in both conditions. But what are the contents of your color experience in the rotation condition and what is the temporal layout of your stream of experiences? How do they compare to the contents and to the temporal layout of your color experience in the stationary condition?

In this section I will argue for the following claims that together are incompatible with the structural matching thesis (I will defend my argument against objections in the following section).

DIFFERENT TEMPORAL CONTENT You experience fast changes of color in the stationary condition, while you experience much slower changes of color in the rotation condition, i.e. *you experience a very different rate of change of color in the two conditions.*¹⁴

SAME TEMPORAL LAYOUT At each time t during the rotation condition just like during the stationary condition, you experience the dots as roughly having the

¹³ Throughout this paper, I will discuss the silencing effect as a form of visual illusion. Following Block (2010), someone might doubt, though, whether there is one way to see (apparent) change *correctly*. If our experience represented absolute *metric* properties such as changing from red back again to red, say, *in one second*, then of course the experience would be correct just in case it represented a change that is in fact happening during one second *as* happening during one second. But if our experience did not represent such metric properties (which is plausible), then why say that veridical perception of change occurs in the stationary condition and not in the rotation condition instead? The rate of change in one condition appears slower as the rate in the other. But which experience should we count as getting the actual rate of change right? In a related context, Block considers the effects of attention on appearances: with attention, for example, objects look to have higher apparent contrast than without attention (Carrasco et al. 2004). Yet, Block argues that this difference in apparent contrast does not imply a difference in correctness conditions. If one were persuaded by this argument, one might run a similar argument for the present case: while in the rotation condition the dots appear to change color slower than in the stationary condition this is not accompanied by a difference in correctness conditions. Indeed, it seems that given the vivid and sizable effect in the present case (up to 10× decrease in apparent rate of change) compared to the rather small effects of attention on, say, apparent contrast (an increase of about 8 %, which is barely above the just noticeable difference) Suchow’s and Alvarez’ silencing results in one sense indeed might be better suited for Block’s purposes. While the issue is interesting, this is not the place for an extended discussion of the connection between Suchow’s and Alvarez’ results and Block’s argument. Nothing in my discussion in this paper will hang on the further philosophical issue discussed in this footnote.

¹⁴ Note that there might be some lag of your experience (i.e. you might experience the dot as having the color it in fact had, say, 20 ms ago). This lag in fact probably depends on the speed of rotation (see Suchow and Alvarez for relevant data and discussion). Nothing in my argument will depend on the existence, size or rotation dependence of such a small lag.

colors they have at t , i.e. *your color experience of color is changing at roughly the same rate in the two conditions.*

Before I get to the defense of these two claims, let me illustrate them by considering a specific dot (call it #53).¹⁵

According to DIFFERENT TEMPORAL CONTENT while in the stationary condition you experience #53 as undergoing very fast color changes, you experience #53 as undergoing much slower color changes in the rotation condition. The rate at which you experience the dot as changing is much slower (i.e. between two and ten times slower) in the rotation condition.

Yet, according to SAME TEMPORAL LAYOUT your experience of #53's color is changing at roughly the same rate in the two conditions. In both conditions your color experience tracks the actual color of the dot: during an interval T you are first experiencing #53's color as being h_0 , then as being h_1 , etc., then h_{360} , then h_0 again. The speed with which your experience is changing from red all the way through the color wheel to red again and so its temporal structure are the same both conditions.

So, there are two scenarios where in each we have streams of experience of identical length, each of which consisting of roughly the same temporal layout of experiences as of a certain non-temporal quality (i.e. hue, shape, etc.), yet that differ dramatically in which changes of that quality they present. So, there is a dramatic mismatch between the temporal layout of your stream of experiences and its temporal content. We thus have a counterexample to the structural matching thesis.¹⁶

Why, then, believe DIFFERENT TEMPORAL CONTENT and SAME TEMPORAL LAYOUT?

Not much argument is needed for DIFFERENT TEMPORAL CONTENT (though I will consider an objection in Sect. 5.4). It is phenomenally evident, I take it, that in the stationary condition you have an experience as of fast changes of color, while in the rotation condition you have an experience as of slower of changes of color. Indeed this is the striking and visually salient effect.¹⁷ In addition, we have the finding (see above) that there is a phenomenal match between how color changes are experienced in a *slowed down* version of the stationary condition and in the rotation condition. The stationary condition itself and the rotation condition thus clearly differ in their temporal content.

SAME TEMPORAL LAYOUT is not as obvious. Why not think that your stream of color experiences also changes more slowly in the rotation condition?

One reason against this would be to consider that the cycle time T which it takes for a dot to change from red back to red must be roughly preserved by the stream of

¹⁵ Though it is no assumption of my argument that you are experiencing each dot individually (See Fn 32).

¹⁶ In addition, the fact that subjects experience a slower rate of change in the rotation condition also shows that a proponent of the structural matching thesis would not be able to retreat to a claim about a merely necessary (but not sufficient) condition for the experience of change like the following: as long as you experience any changes at all, the rate at which your color experience is changing matches the rate of change of color you are experiencing. If my interpretation is correct, Suchow's and Alvarez' illusion demonstrate that the rate at which your experience is changing and the rate of change you are experiencing are able to vary quite independently of each other.

¹⁷ Since the effect is gradual and the experience of change rarely stops completely, it might be even more appropriate to speak of *dampening* the experience of change.

color experiences, otherwise your experience would soon lag several cycles behind (see Lee 2008 for an argument of this sort pertaining to illusions of duration).

The main reason to believe SAME TEMPORAL LAYOUT, though, comes from an experiment conducted by Suchow and Alvarez that strongly suggests that your color experience in both conditions roughly tracks the actual colors of the dots at all times.

Suchow and Alvarez have conducted this experiment in order to rule an alternative explanation of the silencing illusion, on which your experience of color “freezes” (Suchow and Alvarez, p. 1) at the time t_0 when the rotation starts, so that throughout the rotation condition you now experience each dot has having the color it had back then.¹⁸ As we will see, Suchow’s and Alvarez’ experimental results against the freezing proposal also provide strong support for SAME TEMPORAL LAYOUT. They reason as follows.¹⁹ It is well known that the ability to detect a chromatic change depends on the difference between the relevant hues. The larger the difference, the easier the detection. But that dependency, of course, holds for hues that are actually represented by the color system: large differences that are screened off from our perceptual systems would *not* be noticed. Now, according to the freezing proposal motion processing screens off the updating of color information: your color system represents #53 as being one and the same color throughout the rotation condition. Since #53 is represented as being one color, i.e. h_0 , throughout, a change of #53’s actual color to h_0 should not be noticed, since such a change would amount to no difference in *represented color*. Therefore, sudden *flips* back to the hue the dot had at the beginning of the rotation condition should go unnoticed.

Based on this reasoning Suchow and Alvarez came up with the following test condition:

The Flip Experiment At some time t while the ring of color changing dots is rotating the hue of #53 (which at that time is h_t) gets suddenly flipped to some other hue h_{flip} .

It is a prediction of the freezing proposal that subjects should *not* notice a flip back to the original hue h_0 . Furthermore, since larger changes in represented color are easier to notice than smaller changes, the closer on the color wheel h_{flip} was to h_0 the *more* likely it should be that subjects fail to notice a flip.²⁰

¹⁸ Suchow and Alvarez (p. 1) cite empirical evidence of such temporal freezing in some other conditions (see citations therein).

¹⁹ Based on earlier experiments by others (see citations in Suchow and Alvarez).

²⁰ In the flip experiment the dots first rotate for about 2 s (see Suchow and Alvarez, suppl. material to Exp. 3). Though Suchow and Alvarez did not explicitly test for this, the assumption is that during the 2 s before the flip the subject’s experience is the same as in the rotation condition without a flip (after all, there is a fact about the temporal content of your experience during such a long interval (even if not within very short intervals, say, below 500 ms), and that fact does not depend on what will happen in the future). This also seems to be what subjects report. The independence of the experience during the time before the flip from that future flip is confirmed further by flipping experiments under three conditions that differ in what happens *after* the flip: in one the dots continue to rotate after the flip, in one they stop rotating, and in one they are replaced by a checkerboard mask. Suchow and Alvarez find that what happens after the flip makes no qualitative difference to whether subjects notice the flip. A final note about the flip experiment: while the experiment was performed at a single rotation speed (75°/s), the independence of the present experience from the future flip also implies that subjects would experience faster color changes at slower rotation speeds just like in the original rotation condition.

Yet, this is almost the opposite of what Suchow and Alvarez find. Subjects notice flips to h_0 almost all the time (p. 1). Indeed, (roughly) the closer the end result of the flip is to h_0 the *less* likely it is that subjects fail to notice the flip. In contrast to the freezing proposal that predicts that the smallest signal change for your perceptual system would be when the experimenter flips the color to h_0 , and that such a flip should, thus, *not* catch your attention, Suchow and Alvarez find that such flips almost always get noticed. Furthermore, and this is important for present purposes, they find that you are less likely to notice a flip the closer the end result is to the “current” color (flips to a color 20° away on the color wheel, by contrast, are already noticed more than half of the time).²¹ Again, the freezing proposal cannot explain why this should be the case. Suchow and Alvarez, thus, take the results of their flip experiment to be very strong evidence against the freezing proposal and reject it on its basis. Motion processing does not simply prevent updating of chromatic information. Chromatic information still gets updated so that the flip to h_0 at time t *does* make a big difference in represented color and therefore gets noticed.

What is important for present purposes is that the flip experiment also provides strong support for SAME TEMPORAL LAYOUT. Your experience of color seems to be changing in roughly the same way in both the stationary and in the rotation condition. This is because only a claim that entails that in the rotation condition your color *experience* roughly tracks the *actual* colors of the dots (so that your experience of color changes quickly) seems to be able to explain why which flips you notice depends on which color the dot currently has. The flip experiment, then, is a way to get at the temporal structure of experience itself (independently of its temporal content). We don’t need to rely on introspection alone, but can use an empirical study like the flip experiment (against the third motivation for the structural matching thesis considered above).

In response, someone might suggest that Suchow’s and Alvarez’ reasoning might be correct as far as the mechanisms of perception are concerned. Yet, it doesn’t directly tell us anything about the subject’s *experience*. While the *sub-personal* representation of color indeed might not freeze, this is compatible with the claim that your *experience* freezes. On this proposal, at time t your sub-personal mechanisms have updated color information and represent #53 as, say, hue h_{258} (e.g. a bright blue) while your experience has not updated and still represents the color h_0 the dot had at the beginning of the rotation condition (the bright red). Because of

²¹ Which is what is usually called the noticeability threshold (or just noticeable difference JND). This is only about double (maybe three times) the just noticeable difference for color in optimal viewing conditions which is usually around 2–4 nm (measured in physical wavelength) which corresponds to roughly 4° – 10° on the color wheel (see e.g. Shevell 2003). Even under the assumption that viewing conditions are optimal in the stationary condition (which they probably are not, due to crowding) a difference in JND between the two conditions thus is unlikely to fully explain the experience of slowing down by a factor of up to 6–8 (in the case of a rotation speed of $75^\circ/s$). Nevertheless, it would be very interesting to test whether there is a difference in JND between the two conditions. Even better, future research should compare the distributions of “noticings” (like Figs. 2, S4 in Suchow’s and Alvarez’ paper) at various rotation speeds and compare them to the distribution found for the stationary condition. Such a comparison could reveal the temporal fine structure of experience in the various conditions (preliminary results by Jordan Suchow (personal communication) suggest that the distribution of noticings is not wider in the rotation condition than in the stationary condition).

such sub-personal updating, the suggestion continues, you might still detect the flip (since there is big change in the chromatic information sub-personally represented), even though your experience of #53's color is the same before and after the flip.

Yet, this response does not do justice to Suchow's and Alvarez data. The subjects of the flip experiment were instructed to press a key "when they saw the color change" (Suchow, personal communication). But according to the sub-personal updating proposal subjects did not in fact ever see the color change. The color they experienced before and after the flip was the same (i.e. h_0). While it cannot be ruled out with certainty that subjects pressed the key in response to a sub-personally represented change to which their experience was blind (according to their experience, after all, there was no change), such a suggestion would flout the subjects' own report. Given this, and that the flips really do phenomenally feel like changes in color, the sub-personal updating suggestion should be rejected.

This concludes my initial defense of SAME TEMPORAL LAYOUT, and my presentation of the argument against the structural matching thesis. The silencing illusion seems to present two cases where your experience is very different in temporal content, and yet roughly the same in temporal layout.

5 The failure of alternatives

But couldn't a proponent of the structural matching thesis give a different account of the contents of your experiences and their temporal layout in the two conditions that preserves a match between them? We have to show that alternative accounts of what is going on in the rotation condition compared to the stationary condition that are compatible with the structural matching thesis fail. This will be the goal of the present section. While there are several such accounts that initially seem plausible, I will show that all of them can be ruled out either by follow-up experiments by Suchow and Alvarez designed to eliminate such alternatives, or by plausibility considerations. The structural matching thesis can be defeated on (roughly) empirical grounds.²²

5.1 Infrequent updating?

A first view might suggest that the freezing proposal discussed and rejected by Suchow and Alvarez took a good idea too far by suggesting that in the rotation condition color information is not updated at all. What we *should* say, so the proposal, is that color information is updated *less frequently*.²³ The reasoning would go as follows. Since motion processing draws away perceptual resources the chromatic difference that is needed for a manifestation in experience is larger in the rotation condition. Since the colors of the dots are changing smoothly through

²² Of course, we know from Duhem and Quine that *any* theory can be preserved in the face of any piece of evidence. A good empirical argument against the structural matching thesis thus need not be a demonstrative argument.

²³ Thanks to discussion of this point with Enrico Grube, Brian Scholl, and to an anonymous referee of this journal. They convinced me of the importance of this type of proposal. Thanks also to Jordan Suchow for helping me to see its shortcomings.

the color wheel the result of this is that chromatic differences will need to be integrated over larger periods of time until the just noticeable difference is reached. The result is that while in the stationary condition your color experience changes, say, at a rate of 100 changes per second (integrating chromatic differences over roughly 10 ms), in the rotation condition your color experience changes at a slower rate of, say, 10 changes per second (integrating chromatic difference over roughly 100 ms).²⁴ The rate at which your experience is changing then would be ten times slower in the rotation condition and match the rate of change that is experienced as ten times slower. Since on this proposal there is updating, it seems to be compatible with the results of the flip experiment. The structural matching thesis would thus be saved.

We should agree with this proposal that if the rotation condition differed from the stationary condition in updating rate as suggested, then there would be *a sense* in which the temporal layout of your experience differed between the two conditions. Indeed there would even be a certain sense in which your experience changes at a lower rate in the rotation condition.

Nevertheless the proposal does not help to rescue the structural matching thesis. Temporal content (with respect to color) differs between the stationary condition and the rotation condition in the *speed* with which experienced color moves around the color wheel. This is what Suchow and Alvarez have found: subjects adjust the “color speed” (measured in degrees on the color wheel per second) during the stationary condition so that it looks like the “color speed” during the rotation condition. The difference in temporal structure that would match this difference in temporal content would be a difference in the speed of color experience (i.e. how quickly color experience moves around a color experience wheel). According to the infrequent updating proposal, by contrast, there is no difference in the speed of color experience between the two conditions. The two conditions differ rather in how *often* the subject’s color experience changes per unit time. The infrequent updating proposal thus does not predict the subjects’ ability to match the appearance of change between the stationary and the rotation condition in the way they do. The difference in temporal content that would match the difference in temporal layout according to the infrequent updating proposal would seem to be a difference in how *smoothly* experienced color changes are. But such a difference in smoothness is not what subjects observe.

The initial plausibility of the infrequent updating proposal rests on an ambiguity in the notion of the rate at which your color experience is changing. On the one hand, it could mean *the speed* with which your experience *moves from one point* (or region) on the color wheel *to another*. A higher rate of change in this sense means that your color experience is changing slower (in the case of location this corresponds to how quickly something is moving, i.e. the distance covered per unit time). This is the notion that was at issue in Suchow’s and Alvarez’ experiments (since subjects adjusted color speed in the stationary condition to get a phenomenal match with the rotation condition). On the other hand, rate of change could mean *how often* your experience *is updating*. A higher rate of change of color experience in this sense (given that color speed remains the same) means that your color

²⁴ The numbers provided here are just stipulation. Finding the correct number would, of course, be a matter of empirical investigation.

experience is changing less smoothly (in the case of location this corresponds to how “jumpy” something is moving, i.e. at how many distinct locations it is per unit time (while holding the distance covered fixed)). Since the changes you are experiencing in the rotation condition are slower and not less smooth, a proponent of the structural matching thesis needs the first sense, while the present proposal uses the second sense. For this reason the infrequent updating proposal is—after all—of no help (a difference between stationary and rotation conditions in the “speed” sense of “rate of change”, on the other hand, was ruled out by Suchow’s and Alvarez’ flip experiment).

A proponent of the structural matching thesis might respond by appealing to the idea that temporal content and temporal layout only need to “closely match”. On the infrequent updating proposal you might (again using my stipulatory numbers) experience 100 different colors per second in the stationary condition, while in the rotation condition you experience only 10 different colors per second. Even if we agree (with the argument just presented) that this does not *exactly* match a ten times difference in experienced color speed, does it not at least *closely* match that difference in color content? In other words, isn’t the structure of the temporal layout close enough to the structure in the content?

In response consider first that, even if this appeal to what is close enough would save the structural matching thesis, it would not save the explanatory theses. Consider the content-to-layout explanatory matching thesis first. The temporal content of your experience on the view we are discussing would not be sufficient to explain its temporal layout: to be given the rate of change in color you are apparently perceiving (let’s assume: a smooth change at $10^\circ/\text{s}$ instead of $100^\circ/\text{s}$) would not be enough to explain the temporal layout of your experience. Experience does, after all, *not* change smoothly at $10^\circ/\text{s}$, but changes non-smoothly at $100^\circ/\text{s}$ by taking only 10 steps (instead of 100). Consider also the layout-to-content matching thesis. It is hard to see how having an experience that changes 10 times per second and covers 100° on the color circle through these changes would by itself explain why it looks to subjects like they are experiencing color changes of $10^\circ/\text{s}$ (rather than experiencing jumpy changes at $100^\circ/\text{s}$). The infrequent updating proposal seems to be an empirical hypothesis that breaks with any straightforward and simple explanatory relationship between temporal content and temporal layout. Given that most motivations *for* the structural matching thesis, as we have seen, also imply the truth of one of the explanatory matching theses, we would—even if the structural matching thesis itself could be saved by the infrequent updating proposal—still have undermined its motivations.

Yet even the structural matching thesis itself, I believe, should not appeal to a “close match” between an experience that changes 10 times per second instead of 100 times and a content that seems 10 times slower. While the notion of a close match, of course, is not precise (and not meant to be), I find it hard to find any notion on which *that* could amount to a close match. The differences and similarities in the structure of the content between the two conditions (both smooth, yet one fast and the other slow) do not at all seem to match the differences and similarities in the structure of the temporal layout (both equally fast, yet one smoother and the other less smooth). For an analogy compare two runners. Runner A travels at a speed of 10 m/s with 100 steps/s, and B travels at a speed of 100 m/s with 10 steps/s. Do the

temporal properties of our two runners closely match? Obviously not: A runs 10 times slower than B, and B takes 10 times bigger steps than A. On both dimensions (distance/time and steps/time) there is no match. Similarly then, there is no close match between the layout of an experience that changes 10 times per second instead of 100 times (but does not moves around the color wheel any slower) and a content that seems 10 times slower (but has no bigger steps in it).

Overall, then, unless the infrequent updating proposal says that subjects make a mistake when they say that the color changes in the rotation condition look like the color changes in a slowed down version of the stationary conditions, it does not save the structural matching thesis.

5.2 Tracking failure?²⁵

Let us move to a second proposal. There is one clear difference between our two conditions: in the rotation condition the dots are moving, while in the stationary condition they don't. Couldn't a proponent of the structural matching thesis exploit this difference? The experience of change requires object binding across time, one might suggest, since a change in color is always a change from *a single thing* having one color at one time to *that thing* having a different color at a different time. So maybe the structural matching thesis should be understood as follows (applied to change experience): experiences as of color changes of a certain object roughly match the temporal layout of experiences *of one and the same object's* color. A plausible idea the would be that in the rotation condition you do not experience changes in color because you are unable to bind the colors at different times to the same (now moving) object (i.e. dot). Since the dots are moving so fast in that condition, subjects loose track of the identity of those dots, and hence they don't experience their fast changes.

This is indeed sounds like plausible suggestion that preserves the spirit of the structural matching thesis.

A first problem with this idea might be that it doesn't seem to hold for the whole ring of dots. The dots (i.e. the collective) are experienced as going through fast color changes in the stationary condition, but appear not to change (or rather appear to change slower) in the rotation condition. It is not entirely clear how failing to keep track of the individual dots would explain the effect pertaining to the whole display (in response one might say, though, that not experiencing color changes in any individual dot somehow transfers to not experiencing color changes in the dot collective).²⁶

The main problem for the tracking failure proposal though is a different one. It comes from one of Suchow's and Alvarez' follow up experiments. Like the freezing proposal mentioned in Sect. 4 the tracking failure proposal has testable empirical consequences. It implies that the experiential silencing effect should never occur if the dots are not moving. Yet, in new experiments Suchow and Alvarez (2011b) found that silencing is in fact *independent* of whether the dots are moving. Here is

²⁵ Suggested to me by an anonymous referee of this journal.

²⁶ Thanks to Farid Masrouf for this point.

what they did: while in the original experiment *the ring of dots* was rotating, Suchow and Alvarez now constructed a display where the *background* of the ring of dots is rotating. The condition is the following.

The Background Rotation Condition The ring of color changing dots itself remains completely stationary (exactly like in the stationary condition) but a dark background wheel rotates behind the ring of color changing dots.²⁷

Suchow and Alvarez find exactly the same silencing effect here as they did in the original rotation condition. Subjects indicate a slowing down of the changes in color in the background rotation condition. Since the dots are not moving in this new condition subjects should have no difficulty to keep track of the dots (they are, after all, stationary). Failure to keep track of the dots thus cannot explain silencing of change. The effect found in the background rotation condition thus rules out the tracking failure proposal (furthermore, since the effect in the rotation condition and in the background rotation condition is virtually identical, it is unlikely that the tracking proposal is correct for the original condition either).

5.3 Indeterminacy?

So far I have spoken as if the color contents of your experience were fairly determinate. Yet, plausibly the contents of your experience can sometimes be more determinate, and at other times less determinate.²⁸ When you look at a red dot, you might (when, for example, close to the dot) perceive its color either very determinately, as a specific shade of red, or (when, for example, further away) less determinately, as some red or other. In a certain sense, you get it right in either case and yet there could be a phenomenal difference. To connect Suchow's and Alvarez' illusions to such indeterminacy might seem plausible especially because the effect probably depends on the absence of focused attention.²⁹ So, let us consider how a proponent of the structural matching thesis might appeal to color indeterminacy.

To warm up let me, first, consider the most *radical* form of color indeterminacy. According to this proposal in the rotation condition you do not experience #53 as having any specific color at all. While #53 is in fact changing its color *all the way through the color wheel*, your color system can't keep up with these changes (since resources are now needed for motion processing). The result is, so the proposal, that the color #53 is represented as is indeterminate between *all* the hues on the color wheel.³⁰

Of course it is extremely confusing to think of what it would be for something to look that way. It is unclear, how something could appear to be brightly colored (as

²⁷ Online at <http://vimeo.com/18074447>.

²⁸ See, e.g., Tye (2010), Nanay (2010), or Stazicker (2011).

²⁹ Hypothesized by Suchow and Alvarez themselves (2011a, p. 3). Indeed, if you focus attention on any particular dot (and, thus, plausibly get more information about it), the effect visibly disappears for that dot. See also Nanay (2010) and Stazicker (2011) for a proposals about the connection between inattention and indeterminacy in the contents of experience.

³⁰ See Simons (2010) for a proposal in this vein.

the dots do even during the rotation phase), and yet fail to look to be any specific color at all.³¹ Yet, since something strange seems to be going in the context of the Suchow's and Alvarez' illusions, maybe we need such a notion for the present case.

Yet, the radical indeterminacy proposal fails for fairly obvious reasons:

First, it seems to have all the defects of the freezing proposal since it implies that your experience is not changing at all during the rotation condition. In addition, if radical hue indeterminacy were correct, it would have to be correct for *all* dots. Yet, the display looks to have differently colored dots in the sense that at any time some of them determinately look more yellow, others more red, others more blue etc. The radical indeterminacy proposal cannot explain this. At most, it might say that some dots look differently colored from other dots (without any of them looking to be any determinate color). As long as the color representation for each dot is *completely* indeterminate no dot can look more yellow than any other. So, radical indeterminacy can't be what explains the illusion.

Let us then move to less radical indeterminacy proposals that overcome this problem. On these views each dot looks to be some color (i.e. not just any), yet one less than fully determinate. Call this *mild* color indeterminacy. Maybe #53, for example, looks to be red, but no specific red, whereas, say, #54 looks to be blue, but no specific blue. Since on this proposal some dots are represented as having a more yellow color than others, the proposal avoids the problem that affected the radical view.

A proposal of this kind could either maintain that the subject's color experience is constant throughout the rotation condition or that it is changing. Let me consider first the claim that it is constant.

In this case, the proposal fails for two reasons. Both exactly mirror problems for the freezing proposal discussed above (which should be expected since like the radical proposal the present proposal is a variant of the freezing proposal: color representation freezes to an indeterminate color).

First, just like the freezing proposal it is hard to see how the proposal explains the experience of *slowed down changes*, and how the silencing factor could vary, i.e. how it could be that subjects experience slower changes with higher rotation speeds (like in the freezing proposal there seems to be no variable that could vary with the speed of rotation).

Second (and more importantly), it fails to explain the results of the flip experiment in exactly the same way as the freezing proposal, since according to this proposal you experience a constant color throughout the rotation condition. Constant color experience whether determinate or not is incompatible with the evidence for changing color experience provided by the flip experiment (which—to remind us—shows that the likelihood of noticing a flip to any hue is non-uniform and depends on the color the dot actually has at the time of the flip (Suchow and Alvarez (p. 3 Fig. 2)).

Let us then consider an indeterminacy proposal on which the indeterminate color each dot is presented as *changes* throughout the rotation condition. #53, say, is first presented as an indeterminate red, then as an indeterminate blue, etc.

³¹ By contrast, when we see a colored object in dim lighting conditions, we do not see it as being brightly colored. As long as we do see it as being colored at all, we seem to see it at least as being more red-ish or blue-ish.

Now the proposal seems to be a version of the infrequent updating proposal. It improves the original proposal in one respect. While the original proposal seemed to predict infrequent, but large *jumps* from one determinate color to another determinate color, an infrequent updating proposal that adds indeterminacy has an easier explanation of the experience of *smooth* changes, since an experience might smoothly change from an indeterminate red experience to an indeterminate blue experience (a big step if viewed on the color wheel) without any jumps. Yet, like on the infrequent updating proposal the fact that your experience presents indeterminate color seems to have no connection to speed with which your color experience is changing: it does not predict the finding that color changes in the rotation condition perceptually look like a slowed down version of the color changes in the stationary condition. It is unclear why a change from an indeterminate red experience to an indeterminate blue experience in the course of *one* second should be phenomenally like a change from a determinate red experience to a determinate yellow experience to a determinate green experience to a determinate blue experience (plus more intermediate positions) in the course of *ten* seconds (which is the temporal structure of the slowed down stationary condition that in fact phenomenally matches the rotation condition). And further, a change from an indeterminate red experience to an indeterminate blue experience in one second (the temporal structure of the experience) does not seem to match a content where color changes smoothly from a determinate red to a determinate blue in the course of *ten* seconds (which is the temporal content for the rotation condition we get from the phenomenal comparison with the stationary condition). The main problem of the infrequent updating proposal as a way of preserving the structural matching thesis remains even on the indeterminate variant of it.

So, even on this most plausibly rendering, the mild indeterminacy proposal cannot explain the data. It might well be that there is more color indeterminacy in the rotation condition than in the stationary condition. But that indeterminacy by itself cannot explain the phenomenology and the results of Suchow's and Alvarez' tests by itself, and does not help a proponent of the structural matching thesis.³²

³² There is another type of indeterminacy one might think of. One might suggest that the relevant indeterminacy—rather than lying in the color each dot is experienced as lies in your experience of the *whole display* of dots (just like you might see an arrangement of speckles on a hen without seeing each individual speckle, or just like you might weigh a bunch of marbles without weighing each individual marble, you may see an arrangement of colored dots without seeing #53. This suggestion thus would mirror one by Tye (2010) in response to an argument by Dretske (2004)). You have an experience as of a ring of colored dots that is rotating; a visual experience as of *them* (the dots understood collectively); but, so the proposal, it does not follow from this that you have an experience of, say, #53, even though #53 is one of the dots. Thus, so the *objection*, your experience in the rotation condition should be described as an experience as of non-uniformly colored dots, while in the stationary condition you have an experience as of each dot individually (or, at least, a spatially more determinate representation of the ring of dots). *Reply*: while this (like color indeterminacy) might be a difference between the two conditions, the proposal does not do justice to all of the phenomenal and experimental data. There is a difference in *temporal* experience. The phenomenal difference between the two conditions still seems to be—roughly—that in the stationary condition you had an experience of fast color changes while in the rotation condition you experience slower color changes. The appearance of the whole display does not (at least not just) become less determinate in the rotation condition, the “pulsing” experience of color changes of the *whole display* that is phenomenally manifest in the stationary condition is slowed down in the rotation condition. To remind us: when Suchow's and Alvarez' subjects were asked to compare “the rate of change” (p. 3) in the rotation condition to the rate of change in the stationary condition, they indicate a

5.4 Judgment and comparison?

So far, I have assumed that there is a difference between the stationary condition and the rotation condition in the changes you are perceptually *experiencing* (this was implicit in DIFFERENT TEMPORAL CONTENT). I have argued that a proponent of the structural matching thesis cannot explain this difference. But could we not challenge the crucial assumption that the relevant difference is a difference in experience, and think of it as a cognitive difference instead?

The most extreme case of Suchow's and Alvarez' experiment where subjects experience almost no changes at all might be considered as a new form of change *blindness*: while a change (in hue, luminance, size or shape) is happening right in front of your eyes you fail to see the change or have a visual experience of it.³³ Fred Dretske (2004) has recently proposed that other cases of change blindness *are* best understood as cognitive and not as perceptual failures. He suggests that in these cases, we only fail to notice *that there is a difference* between how a certain image is at one time and how it is at a different time (a comparison failure). Our visual experience (i.e. seeing objects and properties), according to Dretske, is completely veridical. The mistake is one of perceptual judgment.

Consider also Phillips' (2009) cognitive treatment of the oddball effect and other "illusions" of duration (see Sect. 2). According to Phillips, as we saw, when subjects say that one stimulus lasted longer than another this should not be taken to reflect a difference in their experience of the duration of these stimuli. It is merely a cognitive failure in how subjects compare (afterwards) both stimuli to each other.

Applied to the present context the cognitive proposal would be that in the rotation condition you *are* in fact experiencing fast changes (exactly the same changes as in the stationary condition). But you make mistaken perceptual judgments: you fail to *notice* that those fast changes are occurring and mistakenly come to believe that the changes during the rotation condition are slower than the changes in the stationary condition (a comparison failure).

Yet, this proposal applies Dretske's idea to a context for which it was never intended, and in which it cannot work. Suchow's and Alvarez illusion is crucially different from the cases of change blindness considered by Dretske. Dretske is only interested in those cases of change blindness where it is not even plausible that you see the changes themselves, because these changes are concealed (through splashes, camera changes, saccades, etc.). As Dretske (2004, p. 3) says:

In situations normally used to demonstrate "change blindness" subjects are exposed to differences (in pictures or scenes viewed sequentially) without

Footnote 32 continued

slowing down. The present proposal thus, again, directly flouts the subject's reports and is incompatible with the phenomenal data.

³³ In fact, in a sense the illusion is better thought to be closely connected to *in-attentional blindness* (you fail to see changes if you don't attend to them). Yet the experience of *slowed down* changes in the absence of attentional resources (like the experience of shorter duration in Tse et al. 2004) shows that the effect of absent attention on time consciousness is more specific than to make the subject "blind" to the changes in front of her eyes. Dretske's account of change blindness though is what is relevant to the present proposal. Thanks for an anonymous referee of this journal of suggesting to discuss this point.

being allowed to experience the change (or apparent change) that gives rise to these differences. [...] For this reason change blindness is more accurately described as difference blindness.³⁴

In the silencing illusions, by contrast, the changes are happening right there in front of the eyes of the subject. There is no evidence nor plausibility to the suggestion that while the subject *claims* not to see fast changes, she in fact does see them. The cognitive treatment of the silencing effect is evidently phenomenally false: you do *not* have visual experiences as of fast, smooth and continuous color changes in the rotation condition (while you do have such experiences in the stationary condition). There is a manifest difference in the phenomenal qualities you are experiencing in the dots between the two conditions (indeed at the start of the rotation there is a salient visual effect of slowing down that gives rise to the striking quality of the illusion).

The same response should be given to Phillips. The silencing illusion shows a clear phenomenal difference in how the changes in the dots appear to the subject. Even if one were convinced by a cognitive treatment of duration effects like the oddball effect (probably in part because the comparison happens *after* both durations have been experienced) a cognitive treatment simply misses the phenomenal data of the silencing illusion (it is easy to experience the fast changes in the stationary condition and the slow changes in the rotation condition *at the same time*: just view two of Suchow's and Alvarez' circles of dots next to each other and start them at different times).³⁵ It might well be that the rate-of-change property represented in experience in some sense is a relative property (so that, for example, there might be no phenomenal difference between two worlds where *everything* is happening twice as fast in one compared to the other).³⁶ That there is a striking difference in your temporal visual experience of the dots, though, is independent of the nature of the change properties that are experienced (just as the fact that a red experience differs in color phenomenology from a green experience is independent of the nature of the color properties that are experienced). What the sections preceding the current one have shown is that a proponent of the structural matching thesis has no account of that evident phenomenal difference.³⁷

6 Beyond the structural matching thesis

The foregoing concludes my discussion of ways a proponent of the structural matching thesis might try to accommodate the silencing effects. The ones that

³⁴ Dretske himself acknowledges this limitation of his proposal (Dretske 2004, p. 16, Fn 6).

³⁵ This is in contrast to the oddball effect. New and Scholl (2009) have provided strong evidence that subjects judge the time of *every* event in the visual field as longer if *one* oddball occurs in it. The oddball effect thus is global and therefore it is impossible to experience different durations of two stimuli at the same time if one is an oddball and the other one is not (this would be so, even if—in contrast to Phillips' view—the experiential and not the cognitive explanation of the oddball effect were correct).

³⁶ See the discussion in Phillips (2009).

³⁷ The same considerations also bear on an anti-realist snapshot model. Because the color changes you are experiencing seem to vary quite independently of how your color experience itself is changing over time, the silencing effect shows that the experience of change is not a phenomenally idle wheel.

seemed initially most appealing, I have shown, fail. Of course, there might be other models that I have not considered. An argument that conclusively proves that the structural matching thesis is false, though, is not what we should expect. What I hope to have shown on the basis of Suchow and Alvarez' findings is that the structural matching thesis is empirically implausible. The burden of argument is on those who would like to defend that thesis.

What are alternative accounts of time consciousness that reject the structural matching thesis? And how do they accommodate Suchow's and Alvarez' findings?

A first model is the *specious present view* (Broad 1923; Tye 2003; Lee 2008).³⁸ It conceives of the experience of temporal properties in analogy to the experience of non-temporal properties. On this model there is no special relationship between any of the temporal properties of experience and the temporal properties that experience represents. The experience of change thus is an additional cognitive achievement (Lee 2008). Temporal properties like change *may* thus be represented by momentary experiences.³⁹

On the specious present view illusions in change experience work like illusions in other visual dimensions. The conditions that lead to a size illusion such as in the Ebbinghaus illusion are a matter of empirical discovery and determined by how size processing actually works. Similarly, the silencing illusions show something about how *change* processing actually works; in particular they show that there is an interference of motion processing with the perception of changes of hue, luminance, shape and size so that these changes appear slower in moving objects. In other cases, temporal experience might be distorted in other ways (on this view the silencing effect thus corroborates Tye's (2003) and Lee's (2008) interpretation of other temporal illusions, see Sect. 2 above).

A second model would be a *retentionist view* (Husserl 1964, very tentatively endorsed also by Kelly 2005). On this model you experience temporal properties in virtue of experiencing what is happening at a time together with a retention (a type of memory) of what happened just before. It seems that this model can also explain the silencing effect. Motion processing in the rotation condition (or the processing of background motion in the background rotation condition), on this model, would probably affect the retention: maybe how far it reaches into the past.

Yet, while retentionism *in general* can explain silencing, a certain initially plausible *type* of retentionism cannot: on this version of the view (which arguable is inspired by cinematic ideas, see Lee 2008), the experience of all temporal properties

³⁸ This is how the terminology is used by Broad and Tye (as well as by Phillips 2008, 2009, forthcoming). Lee calls the view the *instantaneous specious present* view. Chuard (2011) calls the principle the present view accepts "content temporal extension" (p. 5). The terminology in this area, unfortunately, is again very confusing. Barry Dainton, for example, speaks of his own extensional model (which accepts the structural matching thesis, see Sect. 2 above) as well as of the retentional model (see below) also as "specious present" views (see Dainton 2000, 2008, 2010). I here use the terminology in the more narrow sense (as in Tye, Lee and Phillips).

³⁹ How long an experience as of some temporal property needs to last is a strictly empirical question just like the question how long an experience as of, say, a shape property lasts. The specious present view thus can, but need not, accept the so-called principle of simultaneous awareness (Miller 1984) that says that "if one experiences succession or temporal structure at all, then one experiences it at a moment." (Phillips 2009, p. 179).

would be fixed by taking a *complete* (visual) experience together with a retention of an earlier *complete* visual experience. This model fails because the silencing effect shows a fragmentation of time consciousness: in the rotation condition you experience fast changes of location, but only slow changes in color (though both are happening fast). We thus need a *fragmented* model with separate retentions for each visual quality.⁴⁰

Third, there is a certain type of *holistic temporal atomism*. This view needs no retentions nor is the experience of change modeled on the experience of shape or color. Rather which temporal properties are experienced supervenes holistically on the stream(s) of experiences as of non-temporal properties. The temporal series of atemporal snapshots, after all, differs between the rotation condition, the background rotation condition, and the stationary condition. In the first each snapshot differs from the other with respect to the location of each dot, in the second each snapshot differs from the other with respect to the location of the (arms of) the background windwheel, while in the third condition both background as well as the dots are represented at the same location in each snapshot. On this form of temporal atomism any phenomenal difference between the three conditions is completely determined by the just mentioned differences in the temporal series of atemporal snapshots.

Yet, while this temporal atomism gives an account of the supervenience base of the experience of change, the account by itself offer no *explanation* for why in one condition we experience fast changes while in the other we experience slow changes. Even given the temporal layout of snapshots, which changes we are experiencing is an open *empirical* question. In this sense the temporal atomism just considered is crucially different from the snapshot model and the cinematic model; it agrees with both the specious present view and the fragmented retentionist model that the experience of change is not phenomenally idle, and in no sense needs to match the way experience itself is changing over time.⁴¹

The main result of my discussion then is that the silencing effect shows that in an important sense the experience of change is an additional cognitive achievement, a further fact about the phenomenal content of our experience. I have mentioned three models that could accommodate this idea. Further philosophical considerations will need to decide between them or show that they might in fact be compatible.⁴²

⁴⁰ If the arguments in Phillips (2008) are correct, this model collapses into a version of the specious present view (see Phillips 2008, Sect. 7).

⁴¹ Note that holistic temporal atomism in principle could also be an anti-realist view claiming that there is no experience as of temporal properties at all. This anti-realism would need to provide a plausible account of the evident phenomenal difference in something like color dimension between the stationary condition and the background motion condition (the difference in the location dimension evidently is *not* the striking visual effect subjects experience). Much of the discussion in Sect. 5 shows that it will be difficult to explain this phenomenal effect without reference to the experience of change. In this sense, then, my discussion also puts pressure on anti-realism about the experience of time.

⁴² Drawing on the various arguments in the literature: e.g. Dainton (2000, 2008), Tye (2003), Kelly (2005), Phillips (2008, 2009, forthcoming), Lee (2007, 2008); Chuard (2011).

7 Conclusion

I hope to have shown that any view of time consciousness on which there is a close match between the temporal content of experience and its temporal layout is empirically implausible. Whether or not one is convinced of that specific conclusion, I hope to have shown also that Suchow's and Alvarez' silencing illusions provide much to think about for philosophers interested in time consciousness and that important questions about time consciousness can be tackled fruitfully by a combination of empirical study and philosophical analysis. Many open questions about time consciousness, of course, remain. Let them be addressed in the same interdisciplinary spirit!

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