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# Understanding perception of time in terms of perception of change

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**Abstract**

In this paper, I offer an account of the dependence relation between perception of change and the subjective flow of time that is consistent with some extant empirical evidence from priming by unconscious change. This view is inspired by the one offered by William James, but it is articulated in the framework of contemporary functionalist accounts of mental qualities and higher-order theories of consciousness. An additional advantage of this account of the relationship between perception of change and subjective time is that is makes sense of instances where we are not consciously aware of changes but still experience the flow of time.



*Keywords:* Time perception, change perception, William James, higher-order awareness

## 1. Introduction

William James observed that "empty our minds as we may, some form of *changing process* remains for us to feel, and cannot be expelled. And along with the sense of the process and its rhythm goes the sense of the length of time it lasts. Awareness of *change* is thus the condition on which our perception of time's flow depends" (James, 1890, Vol. I, p. 621). The connection between awareness of change and the perception of time's flow can be understood in several ways, but the most appealing is to think of perceived changes as the boundaries of perceived intervals of time, i.e., perceived durations. On this view, awareness of change at time *n* followed by awareness of change at time *n*+2 seconds marks the boundaries of a perceived temporal interval with a duration of 2 seconds. Without perception of duration time would not appear to flow at all and this is why the perception of time's flow is dependent on awareness of change: perception of duration depends on perception in change.

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James' idea can be useful in understanding the relationship between change perception and the perception of time in general. Durations, timing, and the flow of time can all be understood as piggybacking in some way on antecedent instances of perceived change. On this view, represented changes are the building blocks out of which mental representations of time are constructed.

However appealing this idea it runs counter to some of what we know about change perception from neuroscience. In this paper, I offer an account of the relationship between perceived change and subjective time that can both do justice to James' original idea and also sit comfortably with that evidence.

## 2. Time depending on change

### *2.1. The constitutive view*

What could it mean for the awareness of time's flow to depend on awareness of change? The view that James himself seems to endorse is that without awareness of change there would be no subjective flow of time at all. Let us call this particular understanding of the relationship between awareness of change and subjective time *the constitutive view*.

The constitutive view may appear plausible. Consider the example of a person put in a situation where there is no sensory input of any kind, including no sense of the beating of one's heart, no sense of one's breathing, nor even the sense of the relative locations of one's body parts. Would subjective time cease to flow for them entirely?

Arguably, no. A person that perceives no changes because they are deprived of any sensory input would still be able to notice the succession of their thoughts, doubts, and so on. And what if we could take away even those? Then indeed it would appear that the person would not be aware of anything and hence would have no basis on which to form the judgment that time is passing.

But even if the constitutive view is conceptually sound, it does not fit comfortably with phenomena such as change blindness and priming. Change blindness occurs when changes in the world occur simultaneously with a disruption in the flow of visual information. These disruptions can range from substantial (eye saccades, shifts of the entire display) to minute (eye blinks, flickers, mud splashes in the display; Grimes 1996, Henderson & Hollingworth, 1999; Rensink, O'Regan, & Clark, 1997; Simons & Levin, 1997). Priming occurs when perceptually processed information becomes available to psychological processes without the subject being consciously aware of that information (Marcel, 1983; Wiggs & Martin 1998; Ochsner, Chiu, & Shacter 1994). Priming demonstrates that we can perceive things without being aware that we do.

There is now substantial evidence of priming during change blindness (Caudek & Domini, 2012; Fernandez-Duque & Thornton, 2000, 2003; Laloyaux, Destrebecqz, & Cleermans, 2006; Silverman & Mack, 2006). These studies and others like them demonstrate that perception of change and conscious experience of change sometimes comes apart. Furthermore, there is now evidence that unconsciously perceived changes have no effect on subjective time at all (Herbst, Javadi, & Busch, 2012).

This evidence puts pressure on the constitutive view, which assumes that awareness of change and conscious experience of time never come apart because the latter depends, in a strong sense, on the former. Priming during change blindness shows that are situations in which the subjective flow of time is not determined by our awareness of change. And if that is true, then the relationship between awareness of change and subjective time is weaker than James' initial idea might suggest.

### *2.2. The causal view*

On the weaker understanding of the dependence relationship, awareness of change may influence the subjective flow of time, but it does not constitute it. This makes room for priming during change blindness, where we are aware of change and that does not affect our conscious experience. Let us call this *the causal* view.

While this understanding of James' original idea sits more comfortably with neuroscience, it loses some of its explanatory power. We are left without a complete account of the subjective flow of time and also without a clear