



## Review

# Do cortical midline variability and low frequency fluctuations mediate William James' "Stream of Consciousness"? "Neurophenomenal Balance Hypothesis" of "Inner Time Consciousness"



Georg Northoff\*

Royal Ottawa Healthcare Group, University of Ottawa Institute of Mental Health Research, Ottawa, Canada  
 Taipei Medical University, Graduate Institute of Humanities in Medicine, Taipei, Taiwan  
 Taipei Medical University-Shuang Ho Hospital, Brain and Consciousness Research Center, New Taipei City, Taiwan  
 National Chengchi University, Research Center for Mind, Brain and Learning, Taipei, Taiwan  
 Centre for Cognition and Brain Disorders (CCBD), Normal University Hangzhou, Hangzhou, China

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## ABSTRACT

William James famously characterized consciousness by 'stream of consciousness' which describes the temporal continuity and flow of the contents of consciousness in our 'inner time consciousness'. More specifically he distinguished between "substantive parts", the contents of consciousness, and "transitive parts", the linkages between different contents. While much research has recently focused on the substantive parts, the neural mechanisms underlying the transitive parts and their characterization by the balance between 'sensible continuity' and 'continuous change' remain unclear. The aim of this paper is to develop so-called neuro-phenomenal hypothesis about specifically the transitive parts and their two phenomenal hallmark features, sensible continuity and continuous change in 'inner time consciousness'. Based on recent findings, I hypothesize that the cortical midline structures and their high degree of variability and strong low frequency fluctuations play an essential role in mediating the phenomenal balance between sensible continuity and continuous change.

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\* Address: Mind, Brain Imaging and Neuroethics, Canada Research Chair, EJLB-Michael Smith Chair for Neuroscience and Mental Health, Royal Ottawa Healthcare Group, University of Ottawa Institute of Mental Health Research, 1145 Carling Avenue, Room 6467, Ottawa, ON K1Z 7K4, Canada. Fax: +1 (613) 798 2982.

E-mail address: [georg.northoff@theroyal.ca](mailto:georg.northoff@theroyal.ca)  
 URL: <http://www.georgnorthoff.com>

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## 1. Introduction

### 1.1. Aims and parts

“Inner time consciousness” describes our subjective experience of time and how that structures and organizes the various contents in our consciousness, the “stream of consciousness” as [James \(1890a\)](#) said. James characterized the “stream of consciousness” by different phenomenal features like the contents in consciousness, the “substantive parts”, and the linkages or transitional periods between them, the “transitive parts”. The transitive parts themselves can be described by balance between “sensible continuity” and “continuous change”. Most importantly, there seems to be a particular balance between sensible continuity and continuous change which makes possible the stream of consciousness in our inner time consciousness. This touches upon what can also be described as implicit time consciousness as distinguished from explicit time consciousness which shall be discussed below in further detail.

Recent neuroscience has developed several theories of the neural correlates of consciousness with the information integration theory ([Tononi, 2004; Tononi & Koch, 2008](#)) and the global workspace theory ([Baars & Franklin, 2007; Dehaene & Changeux, 2011](#)) being most popular (see [Dehaene & Changeux, 2011; Northoff, 2014b](#) recent overviews). These and other theories concern the neural mechanisms of the contents in consciousness, the substantive parts, in general while not addressing specific phenomenal features like the stream of consciousness in inner time consciousness. Recent proposals for the neural mechanisms of inner time consciousness have been suggested and focused on cognitive functions like working memory or iconic memory ([Fuster, 1997; Kelly, 2005](#)), affective functions ([Craig, 2009b, 2009a, 2010a, 2010b, 2010c; Varela, 1999](#)), or interoceptive functions ([Seth, Barrett, & Barnett, 2011; Wittmann, 2013; Wittmann, Simmons, Aron, & Paulus, 2010; Wittmann et al., 2011; Wittmann, Virginie van Wassenhove, & Paulus, 2010](#)). These approaches focus on stimulus-induced or task-evoked activity related to the various functions during perception and cognition of time which allows accounting well for the contents, the substantive parts, in inner time consciousness. One may thus speak of neuro-cognitive, neuro-affective, and neuro-vegetative hypothesis of ‘inner time consciousness’.

In contrast, these approaches focusing mainly on contents in time leave open the neural mechanisms underlying the transitive parts, sensible continuity and continuous change. The transitive parts allow for the construction of the ongoing stream of consciousness as experienced in inner time consciousness within which the various contents are temporally integrated. As such the transitive parts may be central for constructing specifically the phenomenal features of the stream of consciousness as distinguished from its contentual features, the substantive parts, as we perceive and cognize them. We may thus need to shift our focus from the neural correlates of the perception and cognition of contents in inner time consciousness, the substantive parts, to those neural mechanisms that are related to the construction of the phenomenal features of inner time consciousness, the transitive parts.

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