1- **Commentary on Singh's 'The Cultural Evolution of Shamanism'**

2- **Word Count:**

- Abstract: 60 words
- Main text: 999 words
- References: 1384 words

3- **Toward a neurophysiological foundation for altered states of consciousness**

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10- **Abstract**

Singh's cultural evolutionary theory posits that methods of inducing shamanic altered states of consciousness (ASC) are different, resulting in profoundly different cognitive states. We argue that despite different methods of induction, ASC share neurophysiological features and cause shared cognitive and behavioral effects. This common foundation enables further cross-cultural comparison of shamanic activities that is currently left out of Singh's theory.

11- **Main Text**

Singh's cultural evolutionary theory successfully accounts for multiple aspects of shamanism as a recurrent phenomenon. However, when addressing the evolution of shamanism, Singh rejects altered states of consciousness (ASC) as a crucial element, considering these less important than other elements, such as behavioral adaptations. He further claims that different methods of inducing ASC have "profoundly different physiological and psychological effects" (p.30). One of Singh's reasons for setting aside ASC as explanatory is that he thinks the ASC used by shamans do not have a common neurophysiological basis. Yet, this claim is unsubstantiated. Here, we suggest that ASC both share certain neurophysiological features and give rise to shared cognitive and behavioral effects.

ASC induced by methods as varied as sensory deprivation, shamanic drumming, trance, meditation, endurance running, hallucinogen consumption, and even epileptic seizures produce shared cognitive and behavioral effects including hallucinations, out of body experiences, ego dissolution, enhanced imagery, and a distorted sense of time (see Zuckerman & Cohen, 1964; Suedfeld, 1980; Castillo, 1990; Forgays & Forgays, 1992; Hayashi, et al., 1992; Suedfeld & Eich, 1995; Kjellgren, et al., 2003, 2008; Dietrich, 2003; Vaitl, et al., 2005; Mason & Brady, 2009; Danielson et al., 2011; and Speth, et al., 2016). These shared effects are not likely to be coincidental; rather, it is likely that ASC share certain neurophysiological features that correspond with these cognitive and behavioral effects. Although there is as of yet no consensus as to what these shared neurophysiological features are, it is worth reviewing some evidence supporting the view.

One line of evidence comes from using electroencephalography (EEG) to compare ASC to non-altered states. EEG results indicate that ASC, regardless of induction method, correspond with greater activity in the low frequency bands—delta, theta, and slow alpha (see Takahashi, et al., 2005; Batty, et al., 2006; Cahn & Polich, 2006; and Fox, et al., 2013 for meditaion and relaxiation states; see Neher, 1962; Oohashi, et al., 2002; and Gingras, et al., 2014 for trance and shamanic drumming; see Hayashi, et al., 1992; and Iwata, et al., 2001 for sensory deprivation; see Muthukumaraswamy, et al., 2013; Tagliazucchi, et al., 2016; and Carhart-Harris, et al., 2016 for hallucinogens; and see Danielson, et al., 2011 for epilectic seizures). These frequency bands, in turn, are associated with internally-directed attention and attenuated interaction with the external environment (see, e.g., Benedek, et al., 2014). These results suggest that internally-directed attention might be a common element of ASC. Supporting this view, practices such as drumming, trance, endurance running, and focused meditation simulate sensory deprivation to varying degrees and cause a highly focused internal attention, such that engagement with external stimuli is highly attenuated (see Castillo, 1990; Dietrich, 2003; Lutz, et al., 2008; Gingras, et al., 2014; Dahl, et al., 2015; and Hove, et al., 2016). This disengagement of attention from external stimuli is known as 'perceptual-decoupling,' which helps to sustain internally-directed tasks (Smallwood, et al., 2007; Spreng, et al., 2010; Smallwood, et al., 2011; Hove, et al., 2016). Similarly, hallucinogens that induce ASC impair reactions to external stimuli, but this happens due to the failure of sensory gating in filtering out extraneous stimuli, causing a failure to adequately process incoming information (see Carter, et al., 2005; Greyer & Vollenweider, 2008).

The second line of evidence comes from studies using neuroimaging techniques such as functional magnetic resonance imaging (fMRI). Such studies suggest that one of the most common effects of ASC, known as 'ego dissolution,' or the loss of a sense of self, corresponds with disruptions to the default mode network (DMN). DMN is activated during self-referential processes, such as autobiographical memory retrieval (Raichle, et al., 2001; Buckner, et al., 2008; Boly, et al., 2008). Studies using fMRI have indicated that during ASC induced by various methods including focused meditation (Brewer, et al., 2011), hallucinogen consumption (Carhart-Harris, et al., 2012, 2016; Palhano-Fontes, et al., 2015; Tagliazucchi, et al., 2016; Speth, et al., 2016), and epilectic seizures (Danielson, et al., 2011), the activation of DMN decreases, giving rise to ego dissolution. These studies also reveal that during ASC, regardless of induction method, high functional connectivity is exhibited between three interacting brain networks: default mode, frontoparietal control, and salience (see Brewer, et al., 2011; Hasenkamp, et al., 2012; Hove, et al., 2016; Tagliazucchi, et al., 2016; and Carhart-Harris, et al., 2016). The frontoparietal control network is responsible for cognitive control and attention (Cole & Schneider, 2007; Vincent, et al., 2008; Cole, et al., 2014). The salience network is responsible for the detection of salient events (internal or external) and for directing resources to the relevant neural areas (Seeley, et al., 2007; Christoff, et al., 2009; Menon & Uddin, 2010). Enhanced connectivity between these three large-scale brain networks could explain some of the effects experienced by individuals during ASC, including the perceptual-decoupling discussed above.

This evidence supports the idea that there is a common neurophysiological foundation to ASC. We further claim that a common neurophysiological foundation to ASC can be of significant explanatory value for a cultural evolutionary theory of shamanism. For example, Singh’s theory notes but does not currently explain the shaman’s insensitivity to pain, which in our view would be explained by perceptual decoupling in ASC. Similarly, Singh’s theory does not account for the shaman’s ritualistic practice of using dark times of the day or dark spaces, such as caves, which in our view is explained by the relationship between sensory deprivation and ASC. Finally, Singh’s theory notes but does not currently explain why shamans believe they are not in control of their experience, which in our view is explained by the experience of ego dissolution common to ASC. While ASC and their underlying mechanisms will require further investigation, we argue that it is too soon to reject the idea of a common neurophysiological foundation to ASC. Our argument is consistent with the primary objectives of Singh’s cultural evolutionary theory and can be considered an extension to that theory, as it can help to explain the universality, ubiquity, and endurance of shamanic activities around the world.

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