

Dynamics of the knowledge instinct: Effects of incoherence on the cognitive system

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Abstract

We successfully replicated a study about aesthetic emotions in a different socio-cultural environment. The present results suggest that incoherence is a strong inhibitor for aesthetic chills and verify a positive correlation between pleasure and meaning. These results allow for a scientific study of aesthetic emotions as it is now possible for the experimenter to have two groups of subjects, both exposed to the same stimulation, one group experiencing measurable aesthetic emotions whereas the other does not. We review the literature on the problem of both positive and negative psychogenic shivering and relate this phenomenon to the instinct of knowledge. We discuss the implications of our findings, stress the importance of studying the psychological and physiological effects of incoherence on the central nervous system, introduce a series of hypotheses to be tested in further research and conclude with a plausible explanation for the relation between temperature and cognition in humans.

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1. Introduction

Chills are the sensation of coldness accompanying shivers. Shivers are a homeostatic mechanism. They correspond to small tremors of skeletal muscles producing heat (energy) ordinarily allowing the body to maintain its core temperature at a constant level (Cabanac & Massonnet, 1977; Cabanac & Russek, 1982). In humans, this process is sometimes unrelated to any functional changes in temperature and associated to a highly rewarding experience (Blood & Zatorre, 2001; Goldstein, 1980; Maruskin, Thrash, & Elliot, 2012). This phenomenon has attracted the attention

of scientist due to the fact that it seems to engage neural networks coding for vital parameters (Blood & Zatorre, 2001; Zald & Pardo, 2002) and that it can be inhibited by injection of opioid-antagonists (Goldstein, 1980). Though it has mainly been studied in the laboratory using tonal music or acoustic frequencies (see Table 1), this phenomenon seems to be observable universally across the human species (McCrae, 2007), elicited by various forms of art (Goldstein, 1980; Grewe, Kopiez, & Altenmüller, 2009; Wassiliwizky, Jacobsen, Heinrich, Schneiderbauer, & Menninghaus, 2017; Wassiliwizky, Koelsch, Wagner, Jacobsen, & Menninghaus, 2017) or by the practice of science and various religious rituals (Schoeller, 2015b). When unrelated to changes in temperature levels, there seems to be two apparently contradictory cases of chills in humans: chills related

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Table 1
Studies investigating positive and negative chills in humans

	Positive chills	Negative chills
Stimulus	Goldstein, 1980; Konečni, 2005; Konečni, Wanic, & Brown, 2007; Kuehnast, Wagner, Wassiliwizky, Jacobsen, & Menninghaus, 2014; Menninghaus et al., 2015; Schoeller, 2015a; Schoeller, 2015b; Sloboda, 1991; Wasiliwski et al., in press; Wassiliwizky, Jacobsen, et al., 2017; Wassiliwizky, Koelsch, et al., 2017	Halpern, Blake, & Hillenbrand, 1986; Maruskin et al., 2012
Psychology	Baltes et al., 2011; Harrison & Loui, 2014; Keltner & Haidt, 2003; Konečni, 2005; Konečni et al., 2007; McCrae, 2007; Panksepp, 1995; Panzarella, 1980; Schoeller & Perlovsky, 2016; Sloboda, 1991; see also Chater & Loewenstein, 2015; Fukui & Toyoshima, 2014	Maruskin et al., 2012; Schoeller & Perlovsky, 2015
Physiology	Benedek & Kaernbach, 2011; Blood & Zatorre, 2001; Grewe et al., 2009; Panksepp & Bernazsky, 2002; Sumpf et al., 2015; Wassiliwizky, Koelsch, et al., 2017	Zald & Pardo, 2002; see also: Marazziti, Di Muro, & Castrogiovanni, 1992; Briese & Cabanac, 1991; Oka, 2015; Olivier, 2015

to the subject's greatest hopes (+ve chills) and chills related to the subject's greatest fear (−ve chills). Maruskin and colleagues have hypothesized that these correspond to mechanisms of approach and avoidance (2012). But how does a mind know what to approach or what to avoid?

Schoeller and Perlovsky (2015) have hypothesized that chills might correspond to a satisfaction of the knowledge instinct and proposed a simple mathematical framework to account for both events. The knowledge instinct is modeled as an increase in a similarity function, L , between incoming (bottom-up) sensory signals and available (top-down) mental models. In their framework, −ve and +ve chills correspond to an event where the rate of change of the similarity function, L' , tends toward a null value. That is, when the subject can predict external events in real time and with great accuracy (when sensory signals match mental models at their highest level of organization) or when external conditions do not allow for any accurate predictions (in the case of a child witnessing shades in the dark for example). If this hypothesis proved correct, the study of aesthetic emotions in general and that of aesthetic chills in particular could provide robust foundations for the understanding of biological cognitive systems. These authors proceeded to test their theory in a series of experiments conducted in Denmark (Schoeller & Perlovsky, 2016). Their results suggest that exposing subjects to an incoherent prime prior to a chill eliciting stimulation significantly decreases the likelihood of this subject experiencing chills. As their sample size was rather small ($N = 30$), we chose to replicate this experiment in a different socio-cultural setting. Extending the procedure given in (Schoeller & Perlovsky, 2016), on their arrival at the laboratory, the participants were randomly divided into two groups, each group primed with a different text. The semantic cue was introduced with a question: "Please concentrate, what do you think about this idea?". The participants are slightly younger in this sample and the study was conducted in Paris, three days after the 13/11 attacks.

2. Methods

GROUP 1 is the treatment group. These participants were exposed to the same quote from Pascal as chosen by

Schoeller and Perlovsky (2016): "The supreme function of reason is to show man that some things are beyond reason". Post-experimental interviews with subjects positively revealed that the prime was successful in engaging epistemic behavior. The participants in **GROUP 2** were exposed to an incoherent prime, Chomsky's example: "Colorless green ideas sleep furiously". Post-experimental interviews with the concerned participants positively revealed that the prime was indeed rated by participants as "incomprehensible", "incoherent", (etc.), except for three participants who rated this sentence as "poetic" and "meaningful" and that we excluded from the analysis. We discuss these cases and the linguistic aspects of both these sentences below. In the Scandinavian study, Schoeller & Perlovsky observed a positive correlation between coherence and pleasure, the subjects exposed to the coherent prime rated their experience as more pleasurable than the subjects exposed to an incoherent or neutral prime. By mean of an analog rating scales (0–10), we therefore decided to quantify the amount of pleasure felt by the subject. We also measured by the same means the amount of chills experienced, the frequency of chills felt in day-to-day life and the valence of the experience (positive or negative).

Procedure: The participant entered the laboratory, sat in front of a blank screen in a comfortable chair. She was provided with a factual account of what was going to happen next and gave her informed consent. The experimenter then proceeded to launch the experiment and leaved the room. For 90 seconds the subject was asked to stay still while shown a neutral picture of the ocean. The subject was then asked to concentrate while exposed to a prime that she has been randomly assigned to at arrival in the laboratory. The exact wording of the prime was as follow: "What do you think about this idea? [*Priming*]". After 90 s of prime, the subject was exposed to the chill-eliciting stimulus. The stimulation was 60 seconds long. Once the experiment finished, the experimenter came back into the room and provided the subject with a questionnaire. The questionnaire contained (i) the curiosity and exploration inventory-II by Kashdan et al. (2009), (ii) demographics, (iii) the analog rating scales, (iv) narratological questions regarding chill-eliciting scenes in narratives and (v) various open

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