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# Language and emotions: Emotional Sapir–Whorf hypothesis

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ABSTRACT

An emotional version of Sapir–Whorf hypothesis suggests that differences in language emotionalities influence differences among cultures no less than conceptual differences. Conceptual contents of languages and cultures to significant extent are determined by words and their semantic differences; these could be borrowed among languages and exchanged among cultures. Emotional differences, as suggested in the paper, are related to grammar and mostly cannot be borrowed. The paper considers conceptual and emotional mechanisms of language along with their role in the mind and cultural evolution. Language evolution from primordial undifferentiated animal cries is discussed: while conceptual contents increase, emotional reduced. Neural mechanisms of these processes are suggested as well as their mathematical models: the knowledge instinct, the dual model connecting language and cognition, neural modeling fields. Mathematical results are related to cognitive science, linguistics, and psychology. Experimental evidence and theoretical arguments are discussed. Dynamics of the hierarchy–heterarchy of human minds and cultures is formulated using mean-field approach and approximate equations are obtained. The knowledge instinct operating in the mind heterarchy leads to mechanisms of differentiation and synthesis determining ontological development and cultural evolution. These mathematical models identify three types of cultures: "conceptual" pragmatic cultures in which emotionality of language is reduced and differentiation overtakes synthesis resulting in fast evolution at the price of uncertainty of values, self doubts, and internal crises; "traditional–emotional" cultures where differentiation lags behind synthesis, resulting in cultural stability at the price of stagnation; and "multi-cultural" societies combining fast cultural evolution and stability. Unsolved problems and future theoretical and experimental directions are discussed.

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## 1. Emotional Sapir–Whorf hypothesis

Benjamin Whorf (Whorf, 1956) and Edward Sapir (Sapir, 1985) in a series of publications in the 1930s researched an idea that the way people think is influenced by the language they speak. Although there was a long predating linguistic and philosophical tradition, which emphasized the influence of language on cognition (Bhartrihari, 1971; Humboldt, 1836/1967; Nietzsche, 1876/1983), this is often referenced as Sapir–Whorf hypothesis (SWH). Linguistic evidence in support of this hypothesis concentrated on conceptual contents of languages. For example, words for colors influence color perception (Roberson, Davidoff, & Braisbyb, 1999; Winawer et al., 2007). The idea of language influencing cognition and culture has been criticized and "fell out of favor" in the 1960s (Wikipedia, 2009a) due to a prevalent influence of Chomsky's ideas emphasizing language and cognition to be separate abilities of the mind (Chomsky, 1965). Recently SWH again attracted much academic attention, including experimental confirmations (see the previous references) and theoretical skepticism (Pinker, 2007). Interactions between language and cognition have been confirmed in fMRI experiments (Simmons, Stephan, Carla, Xiaoping, & Barsalou, 2008). Brain imaging experiments by Franklin et al. (2008) demonstrated that learning a word "rewires" cognitive circuits in the brain, learning a color name moves perception from right to left hemisphere. These recent data address, in particular, an old line of critique of SWH: whether the relationships between cultures and languages are causal or correlational and if causal, what is the cause and what is the effect. Franklin et al. (2008) experiments have demonstrated that language affects thinking. This discussion will be continued later but first I would like to emphasize that all arguments and experiments referenced above concentrate on conceptual effects of language.

Emotional effects might be no less important (Guttfreund, 1990; Harris, Ayçiçegi, & Gleason, 2003). In particular indicative are results of Guttfreund (1990): Spanish–English bilinguals manifested more intense emotions in psychological interviews conducted in Spanish than in English, irrespective of whether

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their first language was English or Spanish. Still, experimental evidence suggesting interaction between the emotional contents of languages and cognition is limited, the neural mechanisms of these interactions are not known, and no computational models have existed (Perlovsky, 2006a, 2006b, 2006c, 2009).

This paper derives neurally motivated computational models of how conceptual and emotional contents of language affect cognition. This derivation is motivated by the knowledge about brain modules, rather than individual neurons. The next section reviews conceptual and emotional mechanisms of language and their interaction with cognition. Whereas direct experimental data are inadequate, I briefly review existing theoretical ideas and experimental evidence on language evolution, conceptualizing possible mechanisms, and emphasizing directions for future research. Section 3 summarizes previously developed neuro-mathematical theories of interaction between language and cognition (Perlovsky, 2004, 2006a, 2006b, 2006c, 2009), which correspond to recent experimental data; these models are extended toward heterarchy of the mind. Section 4 derives neurally motivated cultural evolutionary models and demonstrates that different cultural evolutionary paths are favored by differences in interaction between cognition and language. In conclusion I discuss future theoretical and experimental directions.

## 2. Language and cognition

Language is widely considered as a mechanism for communicating conceptual information. Emotional contents of language are less appreciated and their role in the mind and evolutionary significance are less known. Still their roles in ontology, evolution, and cultural differences are significant. Whereas much research concentrates on language-computation, sensory-motor, and concept-intention interfaces (Hauser, Chomsky, & Fitch, 2002), the current paper emphasizes that the primordial origin of language was a unified neural mechanism of fused voicing-behavior, emotion-motivation, and concept-understanding (Deacon, 1989; Lieberman, 2000; Mithen, 2007). It is likely that differentiation of mechanisms involved in language, voicing, cognition, motivation, and behavior occurred at different prehistoric times, in different lineages of our ancestors. This may be relevant to discussions of evolution of language and cognition (Botha, 2003; Botha & Knight, 2009).

I address the current differentiated state of these abilities in the human mind, as well as unifying mechanisms of interfaces-links, which make possible integrated human functioning. The paper concentrates on mechanisms of existing interfaces and their cultural evolution. Before describing in the next section mechanisms of language, concepts, and emotions mathematically I will summarize these mechanisms conceptually in correspondence with general knowledge documented in a large number of publications emphasizing certain aspects that have escaped close scientific attention in the previous research.

### 2.1. Primordial undifferentiated synthesis

Animals' vocal tract muscles are controlled mostly from the ancient emotional center (Lieberman, 2000). Vocalizations are more affective than conceptual. Mithen (Mithen, 2007) summarized the state of knowledge about vocalization by apes and monkeys. Calls could be deliberate, however their emotional-behavioral meanings are probably not differentiated; primates cannot use vocalization separately from emotional-behavioral situations; this is one reason they cannot have language.

Emotionality of voice in primates and other animals is governed from a single ancient emotional center in the limbic system (Deacon, 1989; Lieberman, 2000; Mithen, 2007). Cognition is less differentiated than in humans. Sounds of animal cries engage the entire psyche, rather than concepts and emotions separately. An ape or bird seeing danger does not think about what to say to its fellows. A cry of danger is *inseparably* fused with recognition of a dangerous situation, and with a command to oneself and to the entire flock: "fly!". An evaluation (emotion of fear), understanding (concept of danger), and behavior (cry and wing sweep)—are not differentiated. Conscious and unconscious are not separated. Recognizing danger, crying, and flying away is a fused concept-emotion-behavioral *synthetic* form of cognition-action. Birds and apes can not control their larynx muscles *voluntarily*.

### 2.2. Language and differentiation of emotion, voicing, cognition, and behavior

Origin of language required freeing vocalization from uncontrolled emotional influences. Initial undifferentiated unity of emotional, conceptual, and behavioral(including voicing) mechanisms had to separate-differentiate into partially independent systems. Voicing separated from emotional control due to a separate emotional center in cortex which controls larynx muscles, and which is partially under volitional control (Deacon, 1989; Mithen, 2007). Evolution of this volitional emotional mechanism possibly paralleled evolution of language computational mechanisms. In contemporary languages the conceptual and emotional mechanisms are significantly differentiated, compared to animal vocalizations. The languages evolved toward conceptual contents, while their emotional contents were reduced. Cognition, or understanding of the world, is due to mechanisms of concepts, also referred to as internal representations or models. Barsalou calls this mechanism situated simulation (Barsalou, 2009). Perception or cognition consists of matching internal concept-models (simulations) with patterns in sensor data. Concept-models generate top-down neural signals that are matched to bottom-up signals coming from lower levels (Grossberg, 1988; Perlovsky, 2000) In this simulation process the vague internal models are modified to match concrete objects or situations (Bar et al., 2006; Perlovsky, 2006a).

How these cognitive processes are determined and affected by language? Primates' cognitive abilities are independent from language. Language is fundamental to human cognitive abilities (Perlovsky, 2006a). A possible mathematical mechanism of language guiding and enhancing cognition have been discussed in Perlovsky (2004, 2006a, 2006c, 2007a, 2007b, 2009), Fontanari and Perlovsky (2005, 2007, 2008a, 2008b) and Fontanari, Tikhanoff, Cangelosi, Perlovsky, and Ilin (2009). This is a mechanism of the dual model whereby every concept-model has two parts: cognitive and language. The language models (words, phrases) are acquired from surrounding language by age of five or seven. They contain cultural wisdom accumulated through millennia. During the rest of life the language models guide the acquisition of cognitive models.

### 2.3. Emotions, instincts, and the knowledge instinct

The word emotion refers to several neural mechanisms in the brain (Juslin & Västfjäll, 2008); in this paper I always refer to instinctual–emotional mechanism described in Grossberg and Levine (1987), which is consistent with Cabanac (2002). The word instinct in this paper is used in correspondence with this reference to denote a simple inborn, non-adaptive mechanism of internal "sensor", which measures vital body parameters, such as blood pressure, and indicates to the brain when these parameters are out of safe range. This simplified description will be sufficient for our purposes, more details could be found in Grossberg and Seidman (2006) and Gnadt and Grossberg (2008) and references therein. We