Cognitive neuroscience, reading literary texts, and emotional education

Neuroscienze cognitive, lettura dei testi letterari ed educazione emotiva

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ABSTRACT

The three major jobs of the reading brain are recognizing patterns, planning strategy, and feeling (Wolf, 2007). When we read fiction, we expect to experience emotion (Johnson Laird, Oatley, 2008), and literature is probably the first home of the emotional intelligences (Mayer, Salovey, 1997). According to these assumptions, this paper examines the connection between cognitive neurosciences and reading literature to verify whether the literary text can be used in the field of emotional education. The brain-based interaction between text and reader as an "immersed experiencer" (Zwaan, 2004), and therefore also the processes of comprehension will be synthetically analyzed in the light of recent neuroimaging research. How emotion, metaphor, and mental imagery are connected within the process of interpretation will be particularly investigated. The cognitive approach of embodiment and the emotional state of empathy are also involved in the analysis, because their neurocognitive role allows us to explain why the literary text can become a useful tool to enhance students' emotional competence.

"Le tre funzioni fondamentali del cervello che legge sono il riconoscimento di configurazioni, la progettazione di strategie e la percezione di sentimenti" (Wolf, 2007). Quando leggiamo un'opera di fantasia, ci aspettiamo di sperimentare un'emozione (Johnson Laird, Oatley, 2008) e "la letteratura è probabilmente la prima dimora delle intelligenze emotive" (Mayer, Salovey, 1997). In conformità con questi assunti, il presente articolo esamina la relazione tra le neuroscienze cognitive e la lettura dell'opera letteraria, per verificare se il testo può essere utilizzato nel campo dell'educazione emotiva. Le interazioni, basate sull'attività del cervello, tra il testo e il lettore come uno "sperimentatore immerso" (Zwaan, 2004) e dunque anche i processi di comprensione saranno analizzati sinteticamente alla luce della ricerca recente che si serve di neuroimmagini. In particolare si indagherà sul modo in cui emozione, metafora e immaginazione mentale sono connesse all'interno del processo di interpretazione. Nell'analisi sono pure coinvolti l'approccio cognitivo dell'incorporazione e lo stato emotivo dell'empatia, dato che il loro ruolo neurocognitivo ci permette di spiegare perché il testo letterario può diventare un utile strumento per incrementare la competenza emotiva degli studenti.

KEYWORDS

cognitive neuroscience, literary texts, emotion
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Battro, Fischer and Lena (2008) stated that education is certainly "much more than its neural aspects, but the brain and biological sciences can highlight many of its processes and methods". So finding out if cognitive neuroscience can be useful not only to understand how to improve students' ability in reading literary texts, but also how to foster the development of learnable emotional skills can be interesting in the field of education, and particularly within the ambit of teaching literature.

As far as literary studies are concerned, teachers must promote both cognitive and psychosocial competencies. Literary competencies are students' ability to comprehend, analyze, contextualize, and interpret literary texts, psychosocial competencies are based on the teaching of life skills in a supportive learning environment (World Health Organization, 1994).

In this sense, two kinds of life skills mainly connected to the teaching of literature can be identified. Firstly, the capacity to feel empathy, that is the ability to imagine what life is like for another person, even in a situation that we may not be familiar with. Empathy can help students to understand and accept diversity, and improves interpersonal relations between different individuals. Secondly, the ability to handle emotions and cope with them involves recognizing emotions in ourselves and others, being aware of how emotions influence behavior, and being able to respond to emotions appropriately. A very important element is to learn how to handle difficult and intense emotions such as anger or sorrow, which can have negative effects on students' health if they don't react appropriately.

A. S. Byatt (2004) wrote that "a character in a novel is flesh made words – a human being imagined *in the body and in the mind of the writer*, and then turned into words which are then woven into the whole tapestry of the text – which includes word-patterns from the writer's set of metaphors and ideas, and from those he or she absorbs – more or less consciously – from the culture around them". So the portrait of this character "flesh made words" has to be given by using emotional expressions, which can be characterized, and even predicted, by specific dynamical patterns of interaction between brain, body, and world.

In this particular sense teaching literature means to answer the following preliminary questions: if there is an emotional response in reading literature, what elements are involved in determining it? Can they be determined by constructing the meaning on the base of previous knowledge emotionally characterized? Given the emotional response in reading symbolic and metaphorical texts, can teachers use this assumption in educating the emotional competence? Is the problem of the inferences in comprehending texts also connected with a sort of emotional inferences, which condition and determine comprehension, making it an interpretation? If the literary text deals both with emotions and imagination, readers cannot comprehend it without perceiving emotions: is interpretation the highest form of comprehension because it is enhanced by emotions? Can literature really contribute to the improvement of emotional education and usefully enhance the emotional awareness of students in recognizing either their own or others' emotional state, i.e. their emotional competence?

It is clear that in teaching activities a narratological and theoretical approach should therefore be connected with neurocognitive studies, in order to respond either to the literary demands of reading texts or to their educational aspects.

The activity of reading texts involves special cognitive processes and requires effective timing and integration of multiple networks aiming at recognizing patterns, planning strategy, and feeling through the growing activation of the limbic system and its connections to cognition. Reading a word consists in turning expert attention

to letters, recognizing and connecting them to sounds and orthography to phonology, getting to all that a reader knows about a word, and activating syntactic and morphological processes (Wolf, 2007). In this way information in a visual linguistic format can be linked to meaning: this is the phonological route to reading, because the sound is a mediator in the process of associating print with meaning (Banich, Compton, 2010).

At the same time, understanding discourse implies the comprehension not only of individual words, but also of sentences. Moreover integration across sentence representations to make the understanding coherent is required, as comprehension involves both a model of what the text says, i. e. the text base, made up of ordered propositions, and a model of what the text is about, that is the situation model formed from the text base by combining knowledge sources through additional inference processes (Perfetti, Frishkoff, 2008). Ferstl (2007) suggests a broad extended language network that supports text comprehension. It involves the lateral PFC (prefrontal cortex), including the inferior frontal gyrus and the dorsolateral PFC, the anterior temporal lobes, including the temporal pole, the dorsomedial PFC, including the anterior cingulate cortex, and the posterior cingulate cortex.

The aforementioned neurocognitive processes deal with the ordinary way of reading and understanding a text. As far as literary reading is concerned, comprehension is more complex, even because it is characterized by higher levels of subjective reader responses enhanced by mental imagery and emotions, as the case of metaphor will demonstrate. This cognitive setting is especially due to the main rethorical device of literary texts, the metaphor: "what poets and novelists all have in common is their skill at forming metaphors, linking seemingly unrelated concepts in their brain" (Ramachandran, 2004). In cognitive linguistics this figure of speech expresses the unfamiliar, the target, in terms of the familiar, the source. The metaphor's expressive effectiveness is based on its syntax: "A noun phrase, when predicated of a subject, conveys a trait that is felt to be essential to the subject's very being", on its incongruity, because the reader resolves it "soon enough by spotting the underlying similarity, but the initial double take and subsequent brainwork conveys something in addition", and on "the emotional coloring of the source and the way it bleeds into the target" (Pinker, 2007).

When readers understand abstract concepts metaphorically, two groups of neurons (the source and the target) in the brain are activated at the same time. To demonstrate this fact it is necessary to use the notion of "meaningful node" proposed by Lakoff (2008): "A meaningful node is a node that when activated results in the activation of a whole neural simulation and when inhibited inhibits that simulation. Inferences occur when the activation of one meaningful node or more results in the activation of another meaningful node". When the source and target domains are both active simultaneously, the two areas of the brain for the source and target domains will both be active. This is what the neural theory of metaphor proposed by Lakoff (2008) suggests: "Via the Hebbian principle that neurons that fire together wire together, neural mapping circuits linking the two domains will be learned. Those circuits constitute the metaphor". In this sense the neural theory of language, following the theory of simulation semantics, highlights that "the neural circuitry characterizing the meaning of 'grasp' is the neural circuitry in the mirror neurons that are activated when imagining either performing or perceiving grasping. Perceiving language activates corresponding motor or perceptual areas" (Lakoff, 2008).

Metaphors and idioms, interpreted both verbally and imaginally, may serve a mental modeling function that is basic to readers' everyday thought and expression.

Lakoff and Johnson (1980) suggested that we live by metaphors, and Lakoff (1993) proposed that image-based reasoning is fundamental and abstract reasoning is a special case of imaged-based reasoning using metaphor. He applied this principle to such basic abstract concepts as time (motion in space), causation (physical force), purpose (travel to a destination), and category (container), proposing that as thought moves away from the concrete toward the abstract or the emotional, metaphorical comprehension becomes the norm.

The comprehension of metaphors in and of itself poses interesting complexities for the study of meaning. Both verbal-associative and imaginal processes are implied. Verbal associations keep the relations between the topic and the vehicle categorical and constrained, whereas images provide a meaningful, memorable base for one or both. Novel metaphors in particular appear to need imagery for interpretation, especially vehicle imagery (Sadoski, Paivio, 2001).

The experiments designed to study mental imagery pointed out the cortical areas involved in these processes. When a person is imaging small letters in the center of the mind's eye, activation is greatest in posterior regions of the medial occipital lobes. In contrast, when a person is imaging larger letters, activation occurs over a larger area of visual cortex that includes more anterior regions, which is where more peripheral regions of visual space are processed (Slotnick, Thompson, Kosslyn, 2005).

Functional lateralization during mental imagery may depend on two different characteristics of the mental images to be generated: complexity, which would modulate the degree of involvement of the RH (right hemisphere) ventral route, and lexicality, which would drive the LH (left hemisphere) participation (Mazoyer et al., 2002).

The RH "emerges as vital, perhaps even more important than the LH, in dealing with narratives, metaphors, jokes, moral, and other complex or subtle aspects of language" (Gardner, 1982). In the light of the most recent research the RH is involved in processing certain aspects of prosody and plays an important role in narrative and inference. Narrative refers to the ability to construct or understand a story line, whereas inference refers to the ability to fill in the blanks and make assumptions about material that is implied (Banich, Compton, 2010).

Bottini et al. (1994) suggested that the right posterior regions (specifically, the precuneus) and prefrontal regions reflect a contribution of episodic memory and imagery. Metaphor comprehension may differ from literal sentence comprehension in that metaphors involve retrieving imageable experiences from episodic memory to support interpretation (Brownell, 2000).

At the same time it must be underlined that LH and RH appear to function differently based on the nature of the problem at hand. The left prefrontal cortex (PFC) is more likely to be engaged when a problem requires the extrapolation of patterns to reach correct solutions. There is a critical role of the left PFC in extracting logical patterns in reasoning tasks. In contrast, the right PFC is more to likely to be engaged by problems that do not have a single predetermined correct response, but allow the agent to generate multiple strategies (i.e. plans, hypotheses) that will guide movement in the problem space toward a solution.

Therefore, it is perhaps not surprising that situations that appear novel to the agent, or real-life situations that provide the agent with multiple paths of action, engage the right PFC. Specifically, the ventral aspect of right PFC appears to mediate the generation of set-shift hypotheses, whereas the dorsal region of right PFC appears to mediate the executive aspects (e.g. cognitive monitoring) (Vartanian, Goel, 2007).

The current findings, together with recent imaging studies, suggest that the literal figurative hemispheric language dichotomy in its strong form is not an accurate

representation of the way the brain derives linguistic meaning (Rapp et al., 2006).

Both hemispheres are engaged in the comprehension process of literal or metaphoric expressions. The differential contributions of each hemisphere to literal and figurative language comprehension is relatively subtle and varies during the different processing stages. The RH mechanisms are necessary, but not sufficient, for understanding metaphoric expressions. Both hemispheres work in concert in a complex dynamical pattern during literal and figurative language comprehension (Arzouan, 2009).

At the same time, when an individual is faced with a relatively familiar cognitive task, it is likely to resonate with a specific representation in the LH. But when an individual is faced with a relatively novel cognitive task, it is more likely to resonate with one of the coarser representations in the RH, precisely because these representations are less bounded and less specific (Goldberg, 2009).

The involvement of the RH in understanding figurative meanings has recently drawn growing attention. Recent neuropsychological and imaging studies have shown evidence of the unique contribution of the RH in integrating information to understand discourse themes and ambiguous expressions such as metaphors. Recent brain imaging studies have shown activation in RH areas when subjects are given metaphorical expressions; however, other fMRI studies have found no evidence for RH activation in metaphoric language processing, and, instead, showed increased activation in LH areas.

These contradictory findings might be due to differences in the stimuli and tasks used in the various studies. A distinction should be made between conventional (familiar) metaphors and novel (unfamiliar) ones. According to various models (Giora, 1997; Bowdle, Gentner, 2005) the mechanisms used for comprehending conventional metaphors are different from those used on novel ones. Two fMRI studies by Mashal and Ahrens that distinguished between conventional and novel metaphors have indeed reported more RH activity when processing novel metaphors as compared to conventional metaphoric expressions. Studies which used only familiar metaphors or did not make a distinction (Lee, Dapretto, 2006; Rapp et al., 2004) did not find more RH activity when extracting metaphoric relative to literal meaning (Goldstein, Arzouan, Faust, 2008).

At the same time it is important to underline what Schmidt and Seger (2009) found out when investigating metaphor processing by means of an fMRI experiment. Metaphors recruited the right insula, left temporal pole and right inferior frontal gyrus in comparison with literal sentences. Familiar metaphors recruited the right middle frontal gyrus when contrasted with unfamiliar metaphors. Easy metaphors showed higher activation in the left middle frontal gyrus as compared to difficult metaphors, while difficult metaphors showed selective activation in the left inferior frontal gyrus as compared to easy metaphors. The authors conclude that the right hemisphere is involved in metaphor processing and that the factors of figurativeness, familiarity and difficulty are important in determining neural recruitment of semantic processing.

On the other hand, as previously proposed, it is necessary to highlight how the RH plays an important role in the construction of a coherent representation – emotion is part of this representation – and in processing complex and polysemantic structures (Tapiero, Fillon, 2007) like metaphors. Moreover the aforementioned situation model of comprehension related to the RH cannot be taken into consideration without focusing on the crucial role of emotions and emotional inferences in processing metaphors.

If the experience of emotions involves the limbic system, including the amygdala and several cortical areas in the orbital and medial aspects of the frontal lobe (Purves et al., 2008), and emotions are really important to validate situation models of comprehension (Therriault and Rinck, 2007), either in text processing or in mental representation, it can be interesting to verify if there is a connection between the cortical areas involved in mental imagery and the ones connected with the arousal of emotions.

It has been proposed that narrative emotional imagery activates an associative network of stimulus, semantic, and response (procedural) information (Sabatinelli et al., 2006). Central nervous system concomitants of pleasant, neutral, and unpleasant narrative imagery were investigated through fMRI. Subjects were presented with brief narrative scripts over headphones, and then imagined themselves engaged in the described events. During script perception, auditory association cortex showed increased activation during affectively arousing (pleasant and unpleasant), relative to neutral imagery. Structures involved in language processing (left middle frontal gyrus) and spatial navigation (retrosplenium) were also active during script presentation. At the beginning of narrative imagery, supplementary motor area, lateral cerebellum, and left inferior frontal gyrus were initiated, showing enhanced signal change during affectively arousing (pleasant and unpleasant), relative to neutral scripts. These data are coherent with a bioinformational model of emotion that considers response mobilization as the measurable output of narrative imagery.

So Sabatinelli et al. (2006) confirm a connection between mental imagery and emotion. The link between imagery and metaphor processing was demonstrated by Sadoski and Paivio (2001). Bottini (1994) pointed out that the precuneus and prefrontal regions reflect a contribution of episodic memory and imagery, so that metaphor comprehension may differ from literal sentence comprehension in that metaphors involve retrieving imageable experiences from episodic memory to support interpretation (Brownell, 2000).

Now it is interesting to verify a connection between Bottini's findings and what a recent experiment designed by Immordino Yang et al. emphasizes (2009): the precuneus involved in episodic memory and imagery, according to Bottini, seems to concern also the experience of emotions.

In this fMRI experiment participants were exposed to narratives based on true stories, designed to evoke admiration and compassion. The experience of these emotions engaged brain anterior insula, anterior cingulate, hypothalamus and mesencephalon, but also a novel pattern within the posteromedial cortices (the ensemble of precuneus, posterior cingulate cortex and retrosplenial region), a territory currently known for its involvement in the default mode of brain operation and in self-related/consciousness processes.

In this sense, given the previous remarks about the connections between metaphor, mental imagery and emotion, the latter and the biological machinery underlying it are the obligate accompaniment of behavior, conscious or not (Damasio, 1999). Therefore this behavior concerns the reader's experience of processing metaphor by decoding words, elaborating mental images and feeling emotions simultaneously.

On the basis of such considerations, enjoying a literary text is a cognitive activity. It draws on verbal skills and uses knowledge of the world (declarative memory) and personal experience (episodic memory). These all rely on cortical systems, mostly in the frontal and temporal lobes. Emotions, however, are also sub-cortical. The cortical, cognitive enjoyment of literature is based on these sub-cortical systems (Holland,

2009). Three kinds of arousal from literature can be distinguished: direct emotional stimulation, emotional memories, and emotional situations. How do they work?

Fictional entities can stimulate the readers' emotional system at any point in the life cycle, even when they are recognized as fiction. Readers have the capacity for "absorption" in a pretend world and phenomenologically are all familiar with this state. It happens when they get lost in a novel. Temporarily, as readers of a text, they leave aside the current world with its anxieties and troubles, and live in the imagined world. Once readers enter that state of complete absorption, the events occurring within the imagined world drive their emotional system. Indeed, readers' emotional response to those events is increased "by their being viewed alongside, or from the perspective of, the main protagonists… Once absorbed into an imagined world, the appraisal processes are set to work on the events of that world" (Harris, 2000).

Novels can all stimulate real emotions about unreal events. Readers laugh or weep about what they know is fiction. "The traffic between reasoning and emotions moves in both directions: inferences evoke emotions, emotions evoke inferences. Even though the main link in the evocation of an emotion is an unconscious transition from an evaluation, the first event in the causal chain may be a conscious inference". Readers draw a conclusion of which they are aware, and it leads to an unconscious transition to an emotion. Inferences that create emotions can concern imaginary or hypothetical events. Readers' ability to imagine themselves in other contexts or stories, and "even to imagine what they are thinking, is the mainstay of empathy. Hence, the full range of inferences from unconscious intuitions to conscious deductions can create emotions" (Johnson Laird, 2008).

On the other hand, readers' perception of a text's fictionality plays a role in subsequent empathetic response, by releasing them from the obligations of self protection through skepticism and suspicion (Keen, 2007).

This response is cognitive as the gap-filling activities: readers fill in the gaps by making causal inferences or inferences about the way the world is. But in addition to making causal inferences, readers also fill in the gaps through their emotional responses. Responding emotionally is itself a form of understanding literary texts. If readers want to give a critical account by interpreting them, this requires reflecting on their emotional experience of the work (Robinson, 2007).

This kind of experience implies "that the recruitment of embodied metaphors in some aspects of verbal metaphor understanding is done imaginatively as people recreate what it must be like to engage in similar actions. The key to this imaginative process is simulation, in this case the mental enactment of the very action referred to in the metaphor… Although there is no physical action performed, the mental simulation created has embodied elements as people imagine themselves performing the relevant action" (Gibbs, Matlock, 2008). The thesis of embodied semantics maintains that conceptual representations accessed during linguistic processing are, in part, equivalent to the sensory-motor representations required for the enactment of the concepts described. Aziz-Zadeh et al., using fMRI, tested the hypothesis that areas in human premotor cortex that respond both to the execution and observation of actions—mirror neuron areas—are key neural structures in these processes. Participants observed actions and read phrases relating to foot, hand, or mouth actions. In the premotor cortex of the left hemisphere, a clear congruence was found between effector-specific activations of visually presented actions and of actions described by literal phrases.

These results suggest a key role of mirror neuron areas in the re-enactment of

sensory-motor representations during conceptual processing of actions invoked by linguistic stimuli (Aziz-Zadeh et al., 2006). This experiment shows that when we read a novel mirror neurons simulate the described actions, as though we were doing them ourselves (Iacoboni, 2008).

Mirror-neuron-related responses in both the dorsal portion of the inferior frontal gyrus (pars opercularis in putative BA 44) and in the rostral portion of the inferior parietal lobule (the supramarginal gyrus in putative BA 40) have been demonstrated in humans using different neuroimaging techniques (Iacoboni et al., 2005, Fadiga et al., 2005, Oberman et al, 2007). The results of these studies stress the importance of the role of this system in understanding not only others' actions but their intentions and mental states as well (Pfeifer, Dapretto, 2009), even when connected to fiction. Directly relevant to the neural underpinnings of empathy is the notion that the MNS may provide the neural mechanism by which we can understand others' emotion, a clear prerequisite for the ability to empathize with them. According to such models the anterior portions of the insula play an important role in achieving an emotion representation by connecting the limbic system to mirror areas (Carr et al., 2003).

On the basis of the aforementioned considerations, we can say that reading literature consists in different cognitive processes and implies an integrated neural network dealing, among other important aspects (metaphor, mental imagery, empathy, absorption), with emotion. Now the point is the following: in a school setting whose educational task is not only the teaching of literature, but also the teaching of life skills, can the capacity to feel empathy and the ability to handle emotions be improved by reading literary texts?

In other words, can teachers of literature enhance and consolidate the skills connected to the construct of emotional intelligence (EI)?

The goal should be an increased attention to foster emotional competence, which emphasizes the emotional skills that we need to successfully adapt and cope with in our immediate and social environment. These skills can include reasoning, but the emphasis is on adaptive emotional functioning. The skills of emotional competence are learned and characterize the EI.

The intelligence system consists of a capacity for identifying or inputting information, and a capacity for processing information through both immediate symbol manipulation and reference to expert knowledge (Mayer et al., 2000). Emotional intelligence operates across both the cognitive and emotional systems. It operates in a mostly unitary fashion but is still subdivisible into four branches: emotional perception, emotional integration, emotional understanding, and emotional management. The four key elements of the neural circuitry that governs EI are: amygdala (emotional self-awareness), insular and somatosensory cortex (empathy), orbitofrontal/ventromedial prefrontal cortex (emotional expression, social interaction and behavior, interpersonal problem-solving), anterior cingulate cortex (emotional regulation) (Bechara, Damasio, Bar On, 2007).

As far as emotional education is concerned, "the primary goal for students is to become emotionally literate by gaining a holistic understanding of 'feeling' words", which characterize the range of human experience such as excitement, shame, alienation, and commitment. Emotional literacy fosters social competence by teaching students self- and social awareness, empathy, and healthy communication. Emotional literacy also helps to develop emotion-related skills through the performance of tasks that teach the four fundamental EI skills (i.e., the perception, use, understanding and management of emotions) (Ciarrochi, Mayer, 2007).

The school setting is arguably one of the most important contexts for the learn-

ing of emotional skills and competencies. Emotional education may be provided through a variety of diverse efforts such as classroom instruction, extracurricular activities, supportive school climate, and involvement of students, teachers, and parents in community activities (Matthews, Zeidner, Roberts, 2004).

Curricular based programs (Cohen, 1999) aim to educate students about the values of emotional competencies. They also seek to foster the development of specific skills in these areas (e.g. recognition of emotions in self and others, empathy, conflict resolution). Given that students can learn by observing and modeling real, as well as symbolic, and representational models, curriculum based emotional learning comes naturally with literature, which "is probably the first home of the emotional intelligence" (Mayer, Salovey, 1997).

For example, students can learn much about various feelings when reading literary works that describe characters with the tendency to experience specific emotions (e.g. sadness, fear, distrust, surprise). Students can observe how characters express and show their emotions, what makes the characters feel as they do, how the characters act in response to their feelings, and how effective the various methods of coping employed are.

So, given the fact that reading literature means processing metaphors by decoding sentences, elaborating mental imagery and feeling emotions, the last question is the following: can we hypothesize, in secondary schools, an emotion–based literary curriculum suitable to improve and enhance emotional intelligence? This is not the right place to expose such a curriculum in detail: we can say that it could be made up of a range of literary texts suitable to progressively improve students' literacy linked to emotional skills. It should accustom readers to face emotions by exploiting literary texts and decoding their metaphoric-symbolic level, developing those processes of empathy and absorption previously mentioned. To test if this curriculum works, reliable and valid measures of emotional intelligence and its components are needed. They are important to evaluate the effectiveness of interventions designed to increase emotional intelligence by using literary texts. Three tests (Schutte et al., 1998) can be adapted to this evaluation and seem to be particularly useful: the "Emotional Intelligence Scale" (Schutte et al., 1998), the "Meta-Mood Scale" (Salovey et al., 1995), and the "Larsen and Diener Affect Intensity Measure" (Larsen, Diener, 1987).

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