Curiosity And Pleasure

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Abstract

Heuristic decision making received wide attention due to the work of Tversky and Kahneman (1981) and inspired multiple studies of irrationality of the human mind and a fundamental disregard for knowledge. But what is the source of all human knowledge, including heuristics? We discuss the hypothesis that acquisition of knowledge is a deeply rooted psychological need, a motivational mechanism for perception as well as higher cognition. We report experimental results showing that acquisition of knowledge is emotionally pleasing. The satisfaction of curiosity through acquiring knowledge brings pleasure. This confirms the hypothesis that curiosity or need for knowledge is a fundamental and ancient motivation on a par with other basic needs, such as sex or food. This paper connects curiosity, knowledge, cognition, emotions, including aesthetic emotions of the beautiful, mechanisms of drives, high cognitive functions, minimization of cognitive effort through heuristics, and knowledge maximization. We anticipate our finding to be an important aspect for several classical fields including cognitive dissonance, personality, self, learning, and new directions in cognitive science studying emotions related to acquiring knowledge, personality types in relation to types of knowledge, relating higher cognitive abilities to knowledge-related emotions, and new directions in aesthetics revealing the cognitive nature of the beautiful and music.

Introduction - Drives, emotions, and knowledge

Biologists and psychologists have suggested, at least since the 1950s (Harlow, Harlow, & Meyer, 1950; Berlyne, 1960; Festinger, 1957; Harmon-Jones and Mills 1999), that humans and higher animals possess an innate drive for learning. Its primary or secondary role in an organism was not clear. Analyzing mathematical models of learning, Perlovsky (2006) noted that all such models use some mathematical mechanism of this drive. Perception, cognition, and an ability to satisfy any instinctual need would not be possible without a primary innate drive for learning. In all mathematical models this drive directs the organism to increase a measure of the correspondence between sensor signals and mental representations of the surrounding world. Correspondingly, he called this measure of the correspondence knowledge (Rehder & Hastie, 2001), and suggested that the drive to increase knowledge, the Knowledge Instinct, Ki, (Perlovsky, 2001, 2006) or the Need for Knowledge, Ki, (Kagan, 1972) is innate and primary. First we discuss Ki, curiosity, and other related mechanisms without differentiating them; later we address fundamental differences.

The idea of Ki may seem controversial and contradicting the body of work initiated by Tversky and Kahneman (1981). This aspect of the paper will be discussed in details later. The Ki, related areas of curiosity, including need for cognition (Cohen, 1957; Cohen, Stotland, & Wolfe, 1955; Cacioppo & Petty, 1982; Cacioppo, Petty, & Kao 1984) are areas of extensive research with thousands of publications. However its motivational status, its relations to primary or secondary drives remain confused and unclear in recent research. “Cacioppo and Petty’s… need for cognition… (its) motivational aspect that cannot be… conceptualized as needs, drives, or instincts.” (Cacioppo et al 1996).

Loewenstein (1994) emphasized that “Theorizing about curiosity has been largely moribund… the general loss of interest in motivational phenomena such as curiosity… Virtually all… research has examined the cognitive strategies the people use for problem solving… Almost no research on why people are so powerfully driven to solve such problems… even so many researchers… have been struck by the intensity of individual’s efforts… in the absence of material rewards… Curiosity involves an indissoluble mixture of cognition and motivation… drive or not a drive is probably unanswerable.” In subsequent publications Loewenstein and colleagues concentrated on visceral aspects of curiosity (e.g. Lee, Loewenstein, Ariely, Hong, & Young, 2008). Litman (2005) developed a theory of curiosity related to interest-deprivation and motivational wanting-liking model. Schmidhuber (2009) suggested a theory of curiosity driven by a desire to find a maximally compressed representation of reality. After describing our work, we relate it in more details to the above discussion, and to various existing theories and experimental results.

Here we suggest a motivational theory of curiosity,
addressing the fundamental need for knowledge. We briefly summarize discussions that curiosity is fundamentally important for cognition as a whole. We conceptually review mathematical models of the mind-brain, and discuss that increasing knowledge is a part of all artificial intelligence algorithms and mathematical models of cognition. We argue these models describe a psychological drive that is primary and autonomous at lower levels of cognition (such as perception), and that it acquires aspects of conscious curiosity at higher levels of the mind.

We build on a theory of drives and emotions suggested by Grossberg and Levine (1987). According to this theory, satisfaction or dissatisfaction of a drive is perceived emotionally (consciously or subconsciously). At lower levels of everyday perceptions these emotions usually are below the threshold of consciousness; KI functions autonomously, similar to other bodily needs. For example, stomach functioning could be below a threshold of consciousness as long as it performs its functions as expected, but it immediately rises to a conscious level, if it fails to performs its normal functioning. Similarly, we are not emotionally excited when correctly perceiving an everyday object, such as a chair. However, if normal functioning of perception fails, if KI is dissatisfied at this usually autonomous functioning level, we could feel such a condition highly emotionally, we are terrified. This is a staple of thrillers. Therefore, specific emotions related to KI we identify as aesthetic emotions (Perlovsky, 2010a). They are subjectively perceived as harmony or disharmony between mental representations and surrounding world. These emotions are related to curiosity and to aesthetic emotions (Kant, 1790). Kantian arguments have been reformulated in the contemporary language of psychology and knowledge-related emotions of satisfaction or dissatisfaction of KI have been connected to aesthetic emotions of the beautiful (Perlovsky, 2010a).

The Grossberg-Levine theory of drives and emotions (1987) implies that the KI drive includes mechanisms of sensor-like organs and neural circuitry, which measures the knowledge, the correspondence between mental representations and reality, and thus indicate to an organism satisfaction or dissatisfaction of the KI. The candidate brain circuitry has been discussed in (Levine & Perlovsky 2008; Levine 2009). A satisfaction or dissatisfaction of KI is perceived emotionally. Emotional pleasure is deeply rooted into physiology (Cabanac, 1971; Cabanac, Duclaux, & Spector, 1971; Cabanac & Duclaux, 1970) and has been proposed as the fundamental mechanism of decision-making (Cabanac, 1992; Cabanac & Bonniot-Cabanac, 2007; Perlovsky, 2009). Mathematical models of KI have predicted that a fundamental mechanism of perception and cognition includes an evolution of mental representations from vague to crisp (Perlovsky, 2001, 2006). This has been confirmed in brain imaging experiments (Bar et al, 2006; Perlovsky, 2009).

The trade-off between maximizing knowledge and an opposite drive to minimize effort, including minimizing cognitive effort through heuristic thinking is discussed in (Levine & Perlovsky, 2008; Levine 2009). Both drives are hypothesized to be evolutionary adaptations. Candidate brain pathways involved in KI were analyzed in (Levine 2009). Despite the significance of the topic, referenced evidence and theoretical discussions, experimental studies of knowledge-related emotions have been limited, limited evidence exists for a motivational status of curiosity as related to pure knowledge, without visceral effects and without bodily instincts.

Here we address the curiosity for learning new knowledge, and ask, can the pleasure of this effort be demonstrated experimentally? This issue has not been previously studied and it has a principled significance for the KI hypothesis: is KI a primary drive caused and rewarded with pleasure? The present study explores the hypothesis that indeed satisfaction of curiosity and acquisition of knowledge is experienced emotionally as pleasure. Remaining difficulties are discussed near the end of the paper.

**Methods**

17 women (52.9 ± 17.5 s.d. yr) and 15 men (52.5 ± 14.7 s.d. yr) participated anonymously in the study. After an identification questionnaire: age, gender, level of education, interest in politics, belonging to associations, and marital status, each participant was assigned first to Protocol 1 (P.1) to control for pleasure vs. reading and knowledge independent from curiosity, and second to Protocol 2 (P.2) to explore pleasure vs. curiosity. Protocol 1 controlled for pleasure of knowledge, independent from curiosity. Half the group started with Protocol 1 then Protocol 2, the other half of the group followed the reverse order (P2, then P1). In both protocols, the participant received a list of ten items (statements, questions, or pieces of information), one to explore pleasure vs. learning (P1), and the other to explore pleasure vs. curiosity (P2). The participants were asked the following:

Protocol 1 (P.1):
- on the answering chart "P.1 knowledge" on ten indented lines the participant would indicate with a
YES or a NO, with a pencil mark, whether he/she knew each of the 1-10 pieces of information provided on the knowledge list. The magnitude estimations of previous knowledge about items provided measured this way is abbreviated later as P1. prev.know.

Examples of items from Protocol 1 (Pleasure vs. Knowledge):
Item 1: What is the meaning of the word « Huguenot »?
Item 3: Do you know how to bake bread?
Item 9: Do you know how Van Gogh died?

For each item: on the line below rate the pleasure/displeasure of learning it (after reading the answer).
- ---------------------------------0-------------------------------- +

The magnitude estimations of pleasure of reading the answers provided measured this way is abbreviated later as P1. rtg.pleas.rd.

Protocol 2 (P.2) consisted of a new list of ten questions, different from those in P.1, about various aspects of life or the environment. The participant would rate, with a pencil mark, the intensity of the pleasure/displeasure experienced when reading each piece of information provided on the knowledge list. In the middle of each line a zero indicated absence of any hedonicity (indifference); the right part of the line would indicate positive hedonicity (pleasure) and the left part negative hedonicity (displeasure).

For each item: on the line below rate the pleasure/displeasure of learning it (after reading the answer).
- ---------------------------------0-------------------------------- +

The magnitude estimations of pleasure of reading the answers provided measured this way is abbreviated later as P2. rtg.curios.

- the answering chart "P.2 Pleasure of learning" bore ten 140 mm-long horizontal lines to rate, with a pencil mark, the intensity of the pleasure/displeasure experienced when reading each piece of information that answered each of the 1-10 questions raised on curiosity list. In the middle of each line a zero indicated absence of any hedonicity (indifference); the right part of the line would indicate positive hedonicity (pleasure) and the left part negative hedonicity (displeasure). The magnitude estimations of pleasure of reading the answers provided measured this way is abbreviated later as P2. pleas.learn.

Results

A first-look at the results is contained in correlation matrixes shown in Tables 1 and 2. For this first-look overview of relationships among all variables, categorial variables (No, Yes) were substituted with (0, 1) correspondingly. In Table 1 correlations were computed within the entire data set (32 x 10 = 320) items for each entry in the table. In Table 2 correlations were computed for each subject separately (10 items) and then averaged over all subjects (32) (within-participant computations); again total of 320 items contributed to computation of each entry in the table. Table 2 could give significantly different results from Table 1 for example, if contributions to correlations come from between subject variations, while within subject data were significantly different (say uncorrelated). This example illustrates that Table 1 gives relevant data for testing our hypothesis about correlation between curiosity and pleasure. In reality both tables show comparable correlation between curiosity and pleasure, lead to the same conclusion and this discussion becomes irrelevant. For completeness, Table 3 shows average and standard deviation values.

If somewhat arbitrary, we choose significance level corresponding to p < 0.001 of accepting the null hypothesis if it is true (no correlation), a significance threshold in both cases is approximately 0.53. It is significant to note that only one correlation in each matrix is significant, that is the correlation between rating on curiosity and on pleasure of learning. This confirms the hypothesis that satisfaction of KI has a significant hedonic component for subjects with higher rating on curiosity.

The fact that ratings on pleasure of reading and pleasure of learning do not significantly correlate can be taken as a further indication of the validity of the
results: ratings on curiosity were measured independently from ratings on pleasure from reading and knowledge, when curiosity was not involved (this was the purpose of the first protocol). The correlation matrix in Table 1 gives a sufficient statistical characterization of the data for our purpose. The correlation coefficient of 0.61 between “curiosity” and “pleasure” is equivalent to 37% of variance of each of these variables being explained by the other one.

Discussion

To understand significance and limitations of the present study, we briefly discuss cognitive theories of emotions in addition to those mentioned in the first section. Curiosity is a complex ability, related to several functions of the mind. Most authors as well as Wikipedia (2009) consider it an emotion. Its role in cognition is a subject of long debates. Frijda (1987) developed a theory of emotions in behaviorist tradition, considering emotions as epiphenomena, with the concept of “action tendency” as a focal issue. Emotions are, in this view, tendencies to engage in behavior. He discussed several basic emotions. (The Emotions 1986). Grossberg and Levitin (1987) proposed a cognitive theory of drives and emotions; in this theory emotions are neural signals communicating satisfaction or dissatisfaction of drives to decision-making parts of the brain. Johnson-Laird and Oatley (1987) proposed a different cognitive theory of emotions. Emotions are cognitively based states. Complex emotions are derived from a small number of basic emotions and arise at junctures of social plans. Ortony, Clore, & Collins (1990) consider emotions developed as a consequence of certain cognitions and interpretations. These authors exclusively concentrate on the cognitive elicitors of emotions, and postulate that three aspects determine these cognitions: events, agents, and objects. Ortony & Turner (1990) questioned the view that there exist basic emotions out of which all other emotions are built, and in terms of which they can be explained; these authors suggested that the notion of basic emotions will not lead to significant progress in the field. They assumed that emotions are reduced to appraisals and other states that are not emotions. Cabanac (2002) considered emotions as common currency among motivational states necessary to make decisions in complex environments. Russell (2003) introduced a notion of core affect as an undifferentiated foundation of emotions. Juslin and Västfjäll (2008) discuss a number of neural mechanisms involved with emotions and different meanings implied for the word ‘emotion.’ Perlovsky (2001) introduced specific aesthetic emotions related to KI in the spirit of (Grossberg and Levine 1987), and differentiated them from ‘lower’ emotions corresponding to bodily instincts. Schmidhuber (2009) suggested a theory of curiosity driven by a desire to find a maximally compressed representation of reality. In several respects this theory is similar to Perlovsky (2001) ‘knowledge instinct’ or KI. However, it does not describe recent neuroimaging data about perception mechanisms (Bar et al 2006); the idea of maximal compression, it seems, is narrower, and leads to limited aesthetic ideas vs. (Perlovsky 2010a,b).

Up until this time most authors have discussed only few basic emotions, and the role of huge multiplicity of emotions, especially ‘musical’ emotions seems mysterious. Perlovsky (2010b) considered a process of differentiation of KI and emergence of a multiplicity (an almost continuum) of ‘musical’ emotions. These are differentiated aesthetic emotions, cognitively necessary for reconciliation of cognitive dissonances between any pieces of knowledge, which emerged with evolution of language. In some way musical emotions are differentiation of curiosity. We have not addressed above in sufficient details differences and similarities among KI, need for cognition, and curiosity. KI is very similar to need for cognition. First, KI is a mental operation in the same way as cognition is. At intermediate hierarchical levels of the mind need for cognition may involve solving puzzles, or thinking through and enjoying intellectual challenges. These efforts lead to and to significant extent consist in improving mental representations (with regard to considered puzzles and challenges). So cognition leads to improved knowledge similar to KI. (We would emphasize, although it is secondary to the content of this paper that, e.g. solving puzzles, does not consist exclusively in conscious steps but is a combination of conscious and unconscious mental activity, Perlovsky 2001, 2006). Cognition is usually attributed to hierarchical levels above perception. At these higher levels KI and need for cognition are similar, and their satisfaction or dissatisfaction is experienced emotionally. At lower levels of perception KI acts autonomously, related emotional neural signals are below the level of conscious registration, and comparison to need for cognition is not applicable. More problematic is comparison of KI to curiosity. An excellent illustrative example is some people’s curiosity to contents of tabloids. Does this kind of curiosity lead to improved cognitive representations? Are other drives than KI fundamental to this kind of curiosity? These questions remain open for future
studies. Relations of KI and heuristics discussed by Tversky and Kahneman (1981) need additional clarifications. This requires analyzing cognitive mechanisms of language and cognition (Perlovsky 2009; Perlovsky & Ilin 2010). Language is learned by about 5 years of age, yet ability to understand and act like adults requires the lifetime. And even at the peak of mental powers few people attain crisp and clear understanding of the entire content of culture stored in language. The given references explain these facts as follows. Children can learn language representations early, without a need for life experience, because language representations exist in surrounding language ready-made. Learning cognitive representations requires life experience (and guidance from language representations). Because of this, not only children but also adults, when talking about areas where they lack direct experience, could rely on language and maintain intelligent conversation without real life understanding. Decision making that relies on cultural knowledge stored in language is called decision by heuristics. Heuristics store wealth of cultural knowledge and could be better than judgments from personal life experience. Nevertheless, heuristics repeat what has already been known, and do not lead to accumulation of new cultural knowledge. Language learning is driven by what Pinker (1994) called ‘the language instinct’; it is different from KI or ‘the knowledge instinct’ as discussed above. Language instinct involves only language and does not involve life experience. Heuristics advantage of relying on culturally accepted and established ‘truths’ makes one more certain about his or her decisions. They prevent potentially risky ‘original thinking,’ but at the expense of refusing to acquire new knowledge. We note that in the 11th century Maimonides explained the Original Sin and expulsion from paradise due to Adam’s refusal to think originally. By eating from the ‘tree of knowledge’ Adam acquired the knowledge of heuristics (Levine & Perlovsky 2008).

Bartoshuk, et al. (2005) recently warned that mistakes are made frequently when drawing conclusions from cross modality ratings of intensity as well as of hedonicty (Kubovy, 1999); this issue is avoided in the present study by computing two correlation matrices with essentially the same results. This method gives further strength to the conclusion that pleasure is closely correlated to curiosity, both as a motivation and as a reward.

The present study thus confirms the evidence that pleasure/displeasure takes place as a common currency not only among biological and mental motivations (Cabanac, 1992), but, because mental pleasure has been hypothesized to be different from sensory pleasure (Kubovy, 1999), as well in purely mental conflicts of motivations and in decision making (Ramirez, Bonniot-Cabanac, & Cabanac, 2005). Curiosity, may be added as a correlate with pleasure. Such a result would confirm that satisfying curiosity is rewarding (Eckblad, 1978).

Curiosity seems to be a phylogenetically old motivation that proved selectively advantageous in evolution, animals may have some type of ‘need’ for sensory change (Hughes, 1997). Epistemic curiosity activates reward circuitry and enhances memory (Kang, 2009). The fact that improving knowledge is a zoologically ancient mechanism (Cabanac, Cabanac, & Parent, 2009), primarily based upon hedonicty and thus universal among humans, might be reflected in the absence of any significant correlation found here (Table I) between hedonicty and age or gender.

With evolutionary emergence of representations in the brain, beginning possibly with Amniotes, mechanisms of perception (Cabanac, 1996) had to adapt mental representations to concrete conditions in the world. It is hypothesized, at that level KI emerged as a basic mechanism, fundamental for survival, acting autonomously, like digestion. In evolution, with complex hierarchy of brain representations taking place in the human, from perception to abstract concepts, and higher up to ideas of the meaning and purpose of life, KI has driven evolution of higher cognitive functions (Perlovsky, 2010a).

Knowledge related emotions would potentially influence research in emotional intelligence (Mayer et al, 2001), emotional influence on learning (Levens & Phelps, 2008), cognition and consciousness (Phelps, 2005), self and personality (Luu, Collins, & Tucker, 2000) including personality types in relation to types of knowledge (Bartoshuk, 2010; Mauss & Robinson, 2009; Farb et al, 2010), as well as knowledge-related motivational dimensions of emotions (Harmon-Jones, 2004; Gable & Harmon-Jones, 2010; Perlovsky, 2010a). There are several directions to these future studies including neural mechanisms of the tradeoff between the KI and cognitive effort minimization or need for closure (Levine & Perlovsky, 2008; Levine 2009), qualities of emotions related to KI (Perlovsky, 2010b), and personality types with regard to each of these.

We would emphasize that hedonic aspect of curiosity reported in the Results section is only one in a series of arguments establishing curiosity as a primary need. It should be taken together with theoretical arguments and experimental evidence discussed in the first and this last sections of the paper. Results reported here confirm a path discussed in (Levine & Perlovsky, 2008;
Levine 2009) to reconciliation between heuristic thinking (Tversky & Kahneman, 1981) and knowledge maximizing thinking (Perlovsky 2001, 2006). Mathematical models of roles of emotions in language, higher cognitive abilities including aesthetic, musical, and sublime emotions (Perlovsky, 2006; 2007; 2009; 2010a; b) suggest that aesthetic emotions refer to knowledge-related experiences. Experimental demonstration of the details of involved mechanisms (Levine 2009), their conceptual and emotional aspects at higher cognitive levels, their differentiation, are directions for future research. By confirming that maximization of pleasure optimizes not only physiology but also mental experience, the reported results made a step in the direction demonstrating the fundamental aspect of the KI hypothesis: KI is a primary drive, which satisfaction/dissatisfaction produces pleasure/displeasure. This contributed toward connecting several directions of theoretical explorations.

Authors Contribution(s)

L. Perlovsky
Theoretical formulation of the knowledge instinct and aesthetic emotions

M.-C. Bonniot-Cabanac
Experimental design and data collection

M. Cabanac
Formulation of experimental tests of the theory and experimental design.

All three authors equally participated in writing the paper

References


Schmidhuber, J. Anticipatory Behavior in Adaptive


Illustrations

Illustration 1

Tables

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Age</th>
<th>P1. prev.know</th>
<th>P1. rtng.pleas.rd</th>
<th>P2. ratg.curios</th>
<th>P2. pleas.learn</th>
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<td><strong>0.6099</strong></td>
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Table 1. Correlation matrix computed within the entire data set. For this first-look overview of relationships among all variables, categorial variables (No, Yes) were substituted with (0, 1) correspondingly. A significance threshold here is 0.53, corresponding to \( p > 0.999 \) rejection of the null hypothesis (no correlation). Only one correlation is significant, between rating on curiosity and pleasure of learning, confirming the hypothesis.
Table 3. Average and standard deviation values (for gender computation, we arbitrary assign 1 to males and 2 to females).
Reviews

Review 1

Review Title: You proved that I was right.

Posted by Dr. Sergey Petrov on 16 May 2012 04:01:07 PM GMT

<table>
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<tr>
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<tr>
<td>1</td>
<td>Is the subject of the article within the scope of the subject category?</td>
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<tr>
<td>2</td>
<td>Are the interpretations / conclusions sound and justified by the data?</td>
<td>Yes</td>
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<tr>
<td>3</td>
<td>Is this a new and original contribution?</td>
<td>Yes</td>
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<tr>
<td>4</td>
<td>Does this paper exemplify an awareness of other research on the topic?</td>
<td>Yes</td>
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<td>5</td>
<td>Are structure and length satisfactory?</td>
<td>Yes</td>
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<td>6</td>
<td>Can you suggest brief additions or amendments or an introductory statement that will increase the value of this paper for an international audience?</td>
<td>No</td>
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<td>7</td>
<td>Can you suggest any reductions in the paper, or deletions of parts?</td>
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<td>8</td>
<td>Is the quality of the diction satisfactory?</td>
<td>Yes</td>
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<tr>
<td>9</td>
<td>Are the illustrations and tables necessary and acceptable?</td>
<td>Yes</td>
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<tr>
<td>10</td>
<td>Are the references adequate and are they all necessary?</td>
<td>Yes</td>
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<tr>
<td>11</td>
<td>Are the keywords and abstract or summary informative?</td>
<td>Yes</td>
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Rating: 9

Comment:
From experimental point of view, authors are trying estimate and compare degree of satisfaction one get from getting a question (curiosity) and getting the answer (learning). Emotional side of dealing with information and knowledge is quite close to all actual and potential readers of this and similar articles. There is no doubts that we do have KI and its satisfaction is extremely diversified process, from going to a new restaurant to writing poetry. There are two possibilities to look at the article: consider it disappointing, as there are no surprises: we instinctively know that we are curious, that satisfying one’s curiosity is a pleasure, that more curious people get more pleasure from learning, etc. Another option (that I, personally, would prefer) is get satisfaction from the fact that our intuitive views happen to be true and thank authors for providing the proof.

Invited by the author to make a review on this article? : No

Experience and credentials in the specific area of science:
No experience in experimental psychology

Publications in the same or a related area of science: No

How to cite: Petrov S. You proved that I was right. [Review of the article ‘Curiosity And Pleasure ’ by ].WebmedCentral 1970;3(5):WMCRW001821
Review 2

Review Title: Professor

Posted by Dr. Anatoly V Temkin on 26 Feb 2011 06:47:15 PM GMT

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<td>2</td>
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<td>11</td>
<td>Are the keywords and abstract or summary informative?</td>
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Rating: 8

Comment:
Satisfaction of curiosity brings pleasure. Isn't it obvious? Are psychological experiments needed to prove this obvious statement? Sometimes studying obvious brings unexpected result. It turns out that satisfaction of curiosity is not always pleasant. People rather would not know some things.

But what seems more important is that the kind of pleasure related to curiosity is of an entirely different nature than other kinds of pleasure. Perlovsky, Cabanac, and Cabanac tell us that motivations to search pleasure from curiosity are related to a fundamental human instinct for knowledge. All achievements of human intellect, the authors tell us, are related to this instinct to enjoy curiosity. Even abilities for creating and perceiving the beautiful.

I would prefer if the authors would more elaborate this last statement. Isn't the beautiful related to sex? Are there similarities between sex and curiosity? Is there indeed such a simple source for all human achievements, including the highest ones? Possibly I should continue reading these authors. Is it a trivial stunt or indeed a revelation?

Competing interests: No, I don't

Invited by the author to make a review on this article? : No

Experience and credentials in the specific area of science:
I taught a course on a similar topic

Publications in the same or a related area of science: No

How to cite: Temkin A.Professor[Review of the article 'Curiosity And Pleasure ' by J.WebmedCentral 1970;2(2):WMCRW00513
Review 3

**Review Title:** This is a very curious and bold attempt to experimentally prove existence of the need/instinct for knowledge using hedonistic approach.

Posted by Mr. Alexander J Ovsich on 25 Jan 2011 12:56:24 AM GMT

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**Rating:** 8

**Comment:**
This article presents a very interesting Perlovsky’s attempt to prove his bold hypothesis, that “curiosity or need for knowledge is a fundamental and ancient motivation on a par with other basic needs, such as sex or food”. This hypothesis is a part of the broader framework of his original Knowledge Instinct theory. It is also in sync with Perlovsky’s persistent interest in aesthetics and emotions (for example, see his recent enlightening article “Musical emotions: Functions, origins, evolution” in the Physics of Life Reviews 7 (2010).

Perlovsky could not find better researchers to combine his efforts with than Prof. Marie-Claude Bonniot-Cabanac and Prof. Michel Cabanac, arguably one of the leading researchers in the field of psychology of Pleasure. I ought to mention that Prof. Cabanac just published English translation of his book on Pleasure: “The Fifth Influence or, The Dialectics of Pleasure”. It is one of the most important books on the subject in decades.

The article is a valuable contribution to the important subject that (paradoxically) rarely attracts curiosity of scientists for whom curiosity is considered to be the leading sources of their professional motivation and intellectual pleasure. I share high hopes of Prof. Roberts (Reviewer 3) about the role this article can play in the study of curiosity, and agree with his opinion that “right now ideas about curiosity are no better than common sense”. Unfortunately, it is also true about the level of clarity (or rather vagueness) in understanding concepts and terms that authors of this article had to use in order to express their ideas, i.e. instinct, drive, need, emotion, motivation.

**Invited by the author to make a review on this article?** : Yes

**Experience and credentials in the specific area of science:**
5th Lanzarote International Scientific Workshop on Pleasure 
(2008, Lanzarote, Las Palmas, Spain) 
Academic Organiser: Prof. Michel Cabanac

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Publications in the same or a related area of science: Yes


How to cite: Ovsich A. This is a very curious and bold attempt to experimentally prove existence of the need/instinct for knowledge using hedonistic approach. [Review of the article 'Curiosity And Pleasure ' by ].WebmedCentral 1970;2(1):WMCRW00412
Review 4

Review Title: I had a great pleasure to be curious

Posted by Dr. Laurent Brondel on 18 Jan 2011 07:05:19 PM GMT

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Rating: 9

Comment:
In the paper entitled Curiosity and pleasure, L. Perlovsky, M.-C. Bonniot-Cabanac, and M. Cabanac relate the relationships that exist between pleasantness and curiosity in humans. Such a correlate is fundamental since it extends the role of pleasure/displeasure not only to numerous aspects of physiological regulation and mental motivation (as extensively studied by M. Cabanac), but also to cognitive emotions such as curiosity. Furthermore, the study brings new arguments to the concept of Knowledge Instinct. Finally, it open the field to a range of questions concerning, for example, the role of pleasantness/unpleasantness in neophobia (negative innate curiosity) and curiosity (seen as a positive innate emotion) and the passage from one to the other by learning.

The entire questionnaire could be added in the annexes.

Competing interests: no

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science:
I am associated professor in physiology and I do research on food pleasantness (alliesthesia and sensory-specific satiety)

Publications in the same or a related area of science: No

How to cite: Brondel L I had a great pleasure to be curious [Review of the article ‘Curiosity And Pleasure ’ by ],WebmedCentral 1970;2(1):WMCRW00386
Review 5

Review Title: Understanding the mechanisms of curiosity

Posted by Dr. Patrick Anselme on 20 Dec 2010 04:51:30 PM GMT

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Rating: 9

Comment:
Only very little has been scientifically written on curiosity. The work – both empirical and theoretical – carried out by L. Perlovsky, M.-C. Bonniet-Cabanac, and M. Cabanac is a significant step in the understanding of what makes us curious to learn about the world. The concept of “knowledge instinct” is original and the experimental procedure used in order to test its main prediction (i.e. curiosity is motivated by pleasure) is both simple and powerful. These data, along with those that have been collected by M. Cabanac for more than 40 years, contribute to enrich our understanding of the role that pleasure plays in motivational and cognitive phenomena.

In further investigations, I think that controlling the degree of previous knowledge with respect to the “curiosity vs. pleasure” protocol might be useful, as the participants’ knowledge of the answers can negatively affect curiosity and pleasure about these answers. In this study, this may explain why significant correlations remain low.

Competing interests: None

Invited by the author to make a review on this article?: Yes

Experience and credentials in the specific area of science:
Theoretical studies on the role of motivational processes in the ability of the mind/brain system to reduce uncertainty about environment.

Publications in the same or a related area of science: Yes


How to cite: Anselme P.Understanding the mechanisms of curiosity[Review of the article ‘Curiosity And Pleasure ‘ by ] WebmedCentral 1970;1(12):WMCRW00269
Review 6

Review Title: Beginning of understanding of curiosity

Posted by Dr. Seth Roberts on 19 Dec 2010 06:50:01 AM GMT

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Rating: 9

Comment:
This paper describes a fascinating new way to learn about curiosity -- having subjects rate how much pleasure/displeasure they get from learning something. Implicit in the paper is the idea that curiosity is like thirst. When we are thirsty, drinking is pleasant; when we are not thirsty, it is less pleasant. When we are curious, learning is pleasant; when we are not curious, learning is less pleasant. Michel Cabanac has done a lot of work along these lines. Perhaps the method used in the paper can be used to understand what makes curiosity larger or smaller. This will be the beginning of our understanding of it. Right now ideas about curiosity are no better than common sense.

It would have been helpful to see what the pleasure/displeasure ratings were -- their average values.

Competing interests: no

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science:
I am a professor of psychology and I do research heavily influenced by Cabanac's ideas.

Publications in the same or a related area of science: Yes


How to cite: Roberts S. Beginning of understanding of curiosity[Review of the article 'Curiosity And Pleasure ' by ].WebmedCentral 1970;1(12):WMCRW00262
Review 7

Review Title: Admirable article by Perlovky, Bonniot-Cabanac, and Cabanac on curiosity and pleasure

Posted by Dr. Kent Berridge on 16 Dec 2010 04:04:06 PM GMT

1. Is the subject of the article within the scope of the subject category? Yes
2. Are the interpretations / conclusions sound and justified by the data? Yes
3. Is this a new and original contribution? Yes
4. Does this paper exemplify an awareness of other research on the topic? Yes
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7. Can you suggest any reductions in the paper, or deletions of parts? Yes
8. Is the quality of the diction satisfactory? Yes
9. Are the illustrations and tables necessary and acceptable? Yes
10. Are the references adequate and are they all necessary? Yes
11. Are the keywords and abstract or summary informative? Yes

Rating: 9

Comment:
Perlovsky and colleagues present here an interesting and illuminating analysis of the relation between curiosity or desire to know, and the hedonic pleasure of finding an intellectual answer. A fundamental question in hedonic psychology and affective neuroscience is whether abstract rewards for curiosity and intellectual pursuits are similar in nature and underlying mechanisms to more basic sensory pleasures. The answer has major implications for the possibility of a common neural currency shared by all pleasures.

In this clever study and thoughtful paper, Perlovsky, Bonniot-Cabanac, and Cabanac (a longstanding leader in the scientific study of pleasure) show that discovering the answer to a primed question is reported by people to be hedonically pleasant, using a hedonic scale and language similar to how they might describe pleasant sensations. Perlovsky and colleagues suggest this reflects the operation of a 'need for knowledge' or 'knowledge instinct' that is primed in a person by asking a question to which he or she does not know the answer. The person then wishes to know, and finds obtaining the answer to the primed question hedonically satisfying. Such intellectual satisfactions may indeed tap into the brain circuitry and pleasure processes that evolved to mediate more basic sensory pleasures, as suggested by the authors concept of a common currency for all hedonic events that are experienced as pleasant. All in all, this is a highly valuable contribution.

Competing interests: none

Invited by the author to make a review on this article? : Yes

Experience and credentials in the specific area of science:
Professor of psychology and neuroscience

Publications in the same or a related area of science: Yes

How to cite: Berridge K. Admirable article by Perlovky, Bonniot-Cabanac, and Cabanac on curiosity and pleasure[Review of the article 'Curiosity And Pleasure' by ]. WebmedCentral 1970;1(12):WMCRW00254

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