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# Cognitive factors correlating with the metacognition of the phenomenal properties of experience

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The awareness of the phenomenal qualities of one's experiences can be considered as an instance of metacognition. Although some people take qualia (sensory qualities such as the redness of red) as salient features of phenomenal experience, others have expressed views that doubt or deny the central importance of qualia. How do such cognitive heterogeneities occur? What parameters influence them? Here I examine the relationship between the awareness of the phenomenal qualities of subjective experience (qualia and free will) and general cognitive tendencies. The awareness of qualia was found to be more varied among subjects compared to the belief in free will. Various cognitive tendencies correlated with the metacognition of phenomenal experience. The awareness of qualia was found to increase significantly with age, suggesting a continuous learning process. These results suggest that heterogeneities in the metacognition of phenomenal properties of experience are important constraints in human cognition.

onsciousness has been an important subject of philosophical investigations<sup>1</sup>. Advancements in brain imaging techniques such as fMRI has made it possible to study the neural correlates of consciousness as a field of empirical science<sup>2-5</sup>. Central to the problem of consciousness is the phenomenal properties of experience, or metaphorically, "what it is like to be a bat<sup>6</sup>". Qualia and free will are two key concepts in phenomenology.

The first modern usage of the term "qualia" dates back to the description in 1929 by Clarence Irving Lewis<sup>7</sup>. Although pivotal to the discussion of the phenomenal properties of experience, the concept of qualia has been controversial. Franck Jackson argued that scientific knowledge about the physical properties of the brain is insufficient for an accounting of qualia<sup>8</sup>. Jackson, however, later changed his view, and argued in defense of the idea that physical descriptions of the brain supporting cognition are necessary and sufficient (physicalism)<sup>9</sup>. David Chalmers argued that qualia are central to the "hard problem" of consciousness<sup>10,11</sup>, largely in line with Jackson's original position. Daniel Dennett, on the other hand, denies the central importance of qualia and claims to have effectively "disqualified" qualia<sup>12,13</sup>.

There is evidence that the belief in free will is illusory, constructed through the brain's cognitive mechanisms handling sense and action<sup>14</sup>. From theoretical points of view, the compatibility of the concept of free will with physical determinism has been discussed. While some authors believe in the existence of free will citing quantum mechanics<sup>15,16</sup>, other authors have criticized such views<sup>17</sup>. At best, the question whether humans have free will or not is an open question<sup>18</sup>.

Research into the nature of consciousness has been hindered by the fact that opinions as to even the most fundamental aspects of consciousness sometimes remain controversial and divided. How is it that opinions concerning essential properties of subjectivity such as qualia and free will are diversified, even among learned scholars? How do such cognitive heterogeneities occur? It is interesting to investigate what cognitive factors correlate with the awareness of the phenomenological qualities of our experience.

Awareness of the phenomenal qualities of one's experiences can be considered as an instance of metacognition<sup>19</sup>. Monitoring and control comprise the two main components of metacognition<sup>20</sup>. Metacognition of qualia would be primarily concerned with the former, while that of free will depends on both. Declarative knowledge is an element of metacognition<sup>21</sup>. The subject's level of knowledge in related fields might correlate with the properties of metacognition of phenomenal experience.

Do heterogeneities of opinions among scholars reflect those among the general public? Is the metacognition of the phenomenal properties of consciousness diversified among the populace? If so, how are the elements of metacognition of subjective experience correlated with other cognitive tendencies? Cognitive science addresses

#### Awareness of qualia



#### Cognitive Science Knowledge (Number of known items out of 10)

Figure 1 | The awareness of qualia and knowledge in the cognitive sciences. There was a significant correlation between the reported awareness of qualia and the number of items the subject reported to know out of the 10 items in the cognitive sciences (r = 0.343,  $p = 1.8 \times 10^{-32}$ ). The items in the questionnaire were: a. metacognition, b. theory of mind, c. savants, d. episodic memory, e. sparse coding, f. anterior cingulate cortex, g. dorsolateral prefrontal cortex, h. binding problem, i. scale error, j. reinforcement learning. There was a similar positive correlation between the awareness of qualia and knowledge in the mathematical/physical sciences.

human cognition directly, while the mathematical and physical sciences provide a background for understanding theoretical aspects of free will. Do the knowledge in the cognitive and mathematical/ physical sciences correlate with the nature of metacognition of phenomenal experience?

In order to bridge the gap between philosophical investigations and science, the employment of empirical methods to clarify points of philosophical debates has been suggested ("experimental philosophy<sup>22</sup>"). Here I conducted an investigation into the relationship between various cognitive tendencies and the the subject's evaluation of the phenomenal qualities of his or her own subjective experience (qualia and free will). In addition, in order to investigate the correlation with various cognitive tendencies including those influenced by social and cultural contexts, questions concerning various cognitive attitudes and traits of the subjects were put into the survey.

The subtle nature of the questions necessitated a large sample size, to arrive at a statistically meaningful result encompassing the spectrum of cognitive tendencies among the general public. A web-based questionnare approach was employed, to facilitate the recruitment of a large number of subjects. 1129 subjects reported their views on the phenomenological aspects of their experience.

In the questionnaire, the subjects were first given a brief introduction, with an account of the basic nature of the survey and the declaration that their answers would be used for the purpose of a scientific investigation only. The subjects were informed that the data would be treated statistically, and their individual identities would not be revealed. The subjects were then asked questions regarding their awareness of the phenomenal qualities of experience ("qualia" and "free will"), their academic performances at school, belief in paranormal (although not described as such in the questionnaire) worldviews ("UFOs" and "reincarnation"), theological views (the existence of God), political views (e.g. "liberal" or "conservative"), and views on one's own death. The answers were given in a seven point scale, unless otherwise stated. After answering the questions, the subjects were asked to indicate their informed consents.

#### Results

All Student's t-tests were two-tailed. The metacognition of the subjects for the existence of qualia and free will were significantly different ( $p = 8.3 \times 10^{-36}$ ). A significant portion (22%) of the surveyed

reported that they were not aware of the existence of qualia at all, while a majority of subjects tended to believe in the existence of free will, with 62.7% answering in the affirmative (i.e., in scales 5, 6, and 7). There was a significant correlation between one's understanding of the concept of qualia and the awareness of qualia (r = 0.741,  $p = 2.7 \times 10^{-197}$ ), and between one's understanding of the concept of free will and belief in the existence of free will (r = 0.254,  $p = 5.0 \times 10^{-18}$ ).

A correlation was found between the awareness of qualia and the subject's reported academic performance at school (r = 0.141, p = $2.3 \times 10^{-6}$ ). On the other hand, there was no significant correlation between the belief in free will and the academic performance at school (p = 0.074). There was a significant correlation between the awareness of qualia and knowledge in the mathematical/physical sciences (the number of items the subjects reported to know in question 15, r = 0.189,  $p = 1.4 \times 10^{-10}$ ). There was a negative correlation between the belief in free will and knowledge in the mathematical/ physical sciences (r = -0.081, p = 0.0045). There was a significant correlation between the knowledge in the cognitive sciences (the number of items the subjects reported to know in question 16) and the awareness of qualia, (r = 0.343, p =  $1.8 \times 10^{-32}$ , Fig. 1), but not with the belief in free will (p = 0.18). The analysis of correlations with self-reported IQ (question 18) was dropped, as only 13.6% (153) of subjects reported their IQ scores voluntarily, with an average of 123.4, indicating a possible bias in reporting.

There were correlations between the subjects' political views and the awareness of qualia (r = -0.086, p = 0.0038), and belief in free will (r = -0.114, p = 0.00012), with those affirming the existence of qualia or free will tending to be liberal in their political views. There was a significant correlation between the awareness of qualia and the attitude toward the death penalty (r = -0.183, p =  $5.8 \times 10^{-10}$ ), with those reporting to be aware of qualia tending to be objected to the death penalty. There was no such correlation between the belief in free will and the attitude towards the death penalty (p = 0.20). There were no significant correlations between the awareness of qualia (p = 0.083) or the belief in free will (p = 0.13) and the attitude towards immigration. There was a correlation between the nationalist tendency and the belief in free will (r = 0.096, p = 0.0012, with those believing in free will tending to be more nationalistic), but not with the awareness of qualia (p = 0.90).





**Figure 2** | **Awareness of qualia and age.** There is a significant correlation between the reported awareness of qualia and the subject's age (r = 0.194,  $p = 7.1 \times 10^{-12}$ ). 1129 subjects participated, ranging from 15 to 69 years old, with an average age = 36.4, and a standard deviation = 11.1.

There were no correlations between the fear of the subject's nonexistence after death and the awareness of qualia (p = 0.61) or belief in free will (p = 0.14). On the other hand, there were significant correlations between the fear of pain at death and the awareness of qualia (r = -0.089, p = 0.0028) and belief in free will (r = -0.058, p = 0.049), with those aware of qualia or believing in free will tending to be less fearful of pain at death. There were significant correlations between the belief in the existence of God and awareness of qualia (r = 0.107, p = 0.00033), and belief in free will (r = 0.165, p =  $2.5 \times 10^{-8}$ ).

No significant correlation was found between the the subject's assessment of the difficulty of a scientific elucidation of consciousness and the awareness of qualia (p = 0.29). Thus, although there are well-founded reasons to consider qualia as a (the) hard problem of consciousness<sup>11</sup>, the awareness of the qualities of one's phenomenal experiences do not necessarily lead to the realization of the difficulty of its scientific elucidation. There was a correlaton (r = 0.059, p = 0.046) between the understanding of the concept of qualia and the assessment of the difficulty of a scientific elucidation of consciousness. There was a correlation between the assessment of the difficulty of a scientific elucidation of consciousness and the belief in free will (r = 0.072, p = 0.015), but not with the understanding of the concept of free will (p = 0.49).

Those who hold a physicalist and/or functionalist worldview often claim that the belief in qualia are superfluous or illusory, even indicative of illogical thinking. There were, however, no significant correlations between the awareness of qualia and paranormal world views (belief in visiting aliens on UFOs, p = 0.33, or belief in reincarnation, p = 0.34). On the other hand, there was a positive correlation (r = 0.439, p =  $1.5 \times 10^{-54}$ ) between the paranormal beliefs themselves. ("UFO" and "reincarnation"). In a contrast, there was a significant correlation between the belief in free will and paranormal world views (belief in visiting aliens on UFOs, r = 0.139, p =  $2.6 \times 10^{-6}$ , belief in reincarnation r = 0.202, p =  $6.6 \times 10^{-12}$ ).

The choice of operating systems for computers is culturally constrained, and might reflect the cognitive tendencies of the subjects. The share of operating systems among the 1129 subjects surveyed were 70.7% (801 subjects), 27.5% (301 subjects), 0.97% (11 subjects), and 0.063% (7 subjects) for Windows, Mac OS, Unix, and other operating systems, respectively. The averages of subjects' awareness of qualia were 3.85 and 4.35, with standard deviations of 2.11 and 2.18, for Windows and Mac OS users, respectively. The difference of average awareness of qualia between Windows and Mac OS users was significant (p = 0.00061). The averages of subjects' belief in free will were 5.03 and 4.99, with standard deviations of 1.64 and 1.76 for Windows and Mac OS users, respectively. The difference of average belief in free will between Windows and Mac OS users was not significant (p = 0.74).

Intriguingly, the average reported awareness of qualia was found to increase with age (Fig. 2, r = 0.194,  $p = 7.1 \times 10^{-12}$ ), with those mature in life reporting to be more aware of the qualia in their experience. There was a weaker, but significant increase of a belief in free will with age (r = 0.065, p = 0.030).

#### Discussion

I presented here an investigation into the cognitive factors that correlate with the metacognition of the phenomenal properties of experience. As the data suggest, there is a considerable variability among the general public as regards the understanding of their own experience, especially in terms of qualia.

Discussion of the phenomenology of experience often starts from the tacit assumption that the basic understanding of the phenomenal properties of experience is the same among subjects. Such a view is reinforced by the assumption that qualia are generic features of phenomanl experience, and do not vary in their rudimentary manifestations between people. If such is the case, different opinions as regards the nature of phenomenology would reflect the worldviews and frames of thinking of the authors participating in the discussion, independent of the basic phenomenology of experience.

The data obtained in this study suggests an alternative possibility: The difference in expert opinions concerning the phenomenal properties of experience might correlate with the variable understanding of the phenomenology of experience by the authors, before any theorizing about consciousness takes place. The heterogeneity in the metacognition of phenomenal experience among the general public suggests such a possibility. If such a tendency in the laypersons can be extended to experts, the reason why sophisticated theorizing by learned scholars often lead to contradictions (i.e. polar views on the theoretical significance of qualia in<sup>11</sup> and<sup>13</sup>) might be constrained by the heterogeneity of "folk psychology" parameters that experts share with the laypersons about the phenomenal properties of consciousness.

The significant positive correlations between the awareness of qualia and the knowledge in the physical/mathematical (r = 0.189,

 $p = 1.4 \times 10^{-10}$ ) and cognitive (r = 0.343, p = 1.8 × 10^{-32}) sciences suggest that the appreciation of qualia is not an illusion of irrational nature. This view is reinforced by the fact that there are no significant correlations between the awareness of qualia and paranormal worldviews. It would also be implied that experts well versed in these sciences tend to be more aware of the qualia in experience. This argument, however, cannot explain a case like Daniel Dennett<sup>13</sup>, who is manifestly well learned in the relevant sciences, but argues against the significance of qualia. Controversies as to the nature of phenomenal properties of experience are sometimes difficult to resolve. The problem of whether there is "visual overflow" (i.e., whether there are superfluous information in visual awareness not accessible from conscious cognitive processes<sup>23,24</sup>) is extraordinary in that opinions of learned scholars confront each other in a seemingly incompatible manner. Heterogeneity in the metacognition of one's experience might be the background on which such dichotomies are incurred.

From a wider perspective, it is possible that the metacognition of qualia correlates with various cultural backgrounds. In the choice of operating systems, the general perception is that the artistically oriented tend to choose the Mac OS, the tech type the Unix, and the business oriented or uncommitted the Windows OS. The impression, therefore, would be that those sensitive to the sensory qualities of experience tend to choose Mac OS. The data presented here confirm that Mac OS users are significantly more aware of qualia in their experience compared to Windows users. This result suggests the possibility that the metacognition about one's own phenomenal experience might correlate with other cognitive tendencies constrained by culture.

The cognitive tendencies related to the phenomenal properties of experience might be related to a spectrum of cognitive traits, enhanced by metacognitive realizations of one's experience. The tendency of those who are aware of qualia to be opposed to the death penalty (r = -0.183,  $p = 5.8 \times 10^{-10}$ ) is a case in point. The idea that becoming aware of the phenomenal dimensions of one's experience constitutes a form of "enlightenment" has been expressed by some authors (e.g<sup>25</sup>.).

The linear increase of the average perceived awareness of qualia with age (r = 0.194,  $p = 7.1 \times 10^{-12}$ ) suggests that the transition from an "unaware" state to an "aware state" could occur at any age, consistent with the idea that there is no clear "critical period" for the metacognition of phenomenal experience. Becoming aware of one's phenomenal experience is thus a continuous learning process, tightly coupled with the higher order thoughts of consciousness<sup>23</sup>.

When interpreting correlations based on Pearson's correlation coefficients, one should be aware of false positives as they are not robust and are overly sensitive to outliers<sup>26</sup>. Even when the significance level is nominally high, it may be due to biases in the subject's response not attributable to the question itself. The subjects participating in this study were recruited through the author's twitter account, and might have had tendencies different from randomly chosen samples in the Japanese populace. Inputs given in the questionnaire's free writing space indicate that the subjects' interest in the mind/brain problem was possibly stronger compared to the general public, consistent with the fact that they chose to participate in the questionnaire. The subjects might have been more knowledgeable in the cognitive or mathematical/physical sciences compared to the general public. The IQ scores reported by the subjects (not used in the analysis) were nominally higher than average. An analysis based on the access to a popular web-capture service site (http://www. cman.jp/BrowserCapture/browser/share\_201112.html) suggest that the shares for Windows and Mac OS among computer users in Japan at the time of web questionnaire (December 2011) were 90.3% and 7.3%, respectively. The OS statistics among the participants in this study (70.7% and 27.5% for Windows and Mac OS users, respectively) suggest an overrepresentation of Mac users. Tendencies

associated with Mac OS users (e.g. sensitivity for qualia) might have been overemphasized. These possible biases in the analyzed must be taken into account when interpreting the data.

In sum, I have reported here an investigation into the cognitive factors correlating with the metacognition of the phenomenal properties of experience. It has been found that the metacognition of qualia is varied among the general public, possibly giving rise to the incompatible opinions among experts on the significance of the phenomenology of experience. Such investigations in the field of experimental philosophy<sup>22</sup> would facilitate the understanding the nature of human cognition in its full spectrum.

#### Methods

Web-based questionnaires were conducted using google docs (Google corporation, Mountain View, CA, U.S.A. provided at docs.google.com). The author's twitter account (@kenichiromogi, with ~352000 followers at the time of investigation) was used in the call for participation. Participations were accepted for 12 consecutive days in December 2011. The questionnaire was conducted in the subjects' native language of Japanese. The procedure was approved by the cognitive sciences ethics committee of Sony Computer Science Laboratories. The participants gave informed consent at the end of the questionnaire.

There were nominally 1150 entries during the period open for participation. When checked for irregularities, eighteen subjects were found to erroneously have made entries twice, while one subject was found to have made four entries. The answers in these multiple entries were found to be consistent within a subject in all cases, indicating the authenticity of the entries. Consequently, the multiple entries were processed as a single entry per subject. 7 subjects were found to have entered their age using Chinese characters (a common irregularity in the Japanese webspace) and were converted into Arabic numerals. Apart from these irregularities, there were no apparent cases of irrelevant entries. After the irregularity check, filtering and rectifications, entries of 1129 subjects (662 males and 467 females, average age = 36.4, standard deviation = 11.1, ranging from 15 to 69 years old) were processed for further analysis.

Category 1 questions were queries into the subjects' basic understanding of the phenomenal properties of experience. Question 1: How much do you understand the concept of qualia? Question 2: How much are you aware of the existence of qualia? Question 3: How much do you understand the concept of free will? Question 4: Do you think humans have free will? Question 5: How possible do you think is a scientific elucidation of consciousness? The answers were given in a seven-point scale.

Category 2 questions were designed to probe into the subjects' cognitive backgrounds and worldviews. Question 6: Do you think that God exists? Question 7: Do you think UFOs are flying to the earth, with aliens on them? Question 8: Do you believe in reincarnations? Question 9: Are you liberal or conservative in your political views? Question 10: How important do you think it is to consider the interests of the nation you belong to? Question 11: How much should we restrict the immigration of foreigners? Question 12: Are you against or for the death penalty? Question 13: How afraid are you of the fact that you might not exist after death? Question 14: How afraid are you of the pains that you might feel when you die? The answers were given in a seven-point scale.

Category 3 questions assessed the subjects' level of general knowledge about the mathematical/physical and cognitive sciences. Question 15 (knowledge in the mathematical/physical sciences): About which of the following ten concepts do you have a sufficiently good knowledge to explain to others? a. calculus, b. harmonic series, c. the continuum hypothesis, d. fixed-point theorem, e. relativity theory, f. quantum mechanics, g. physicalism, h. statistical mechanics, i. entropy, j. super-conductivity. Question 16 (knowledge in the cognitive sciences): About which of the following ten concepts do you have a sufficiently good knowledge to explain to others? a. metacognition, b. theory of mind, c. savants, d. episodic memory, e. sparse coding, f. anterior cingulate cortex, g. dorsolateral prefrontal cortex, h. binding problem, i. scale error, j. reinforcement learning. The answers were given by checking the boxes next to the items the subjects felt they had sufficient knowledge.

The subjects finished the questionnaire by answering the follow-up questions. Question 17: How good were you academically when you were at school? Question 18: If you know your IQ score, please enter it. Question 19: Which operating system do you use most often? (Windows, Mac OS, Unix, or others) Question 20: How old are you? Question 21: Your gender? Question 22: Write freely about consciousness.

After answering the questions, the subjects were asked to indicate their informed consents. No subject refused to give the consent at this stage.

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#### **Additional information**

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