Research on the human brain, the external brain and the public external brain

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Abstract: Information technology such as Internet, Internet of Things and mobile communication is the infrastructure of information communication under network digital space. With increasingly completion of information technology, people can instantly access and get information in digital network space. The cognition and learning of the human brain can achieve real-time synchronization with cyberspace. Digital cyberspace is like an external brain and a public external brain, and they are part of human brain's memory and thinking. This paper defines the human brain, the external brain and the public external brain, and summarizes attributes and relationships of the three, moreover proposes human cognition and action models in the digital age to understand human behavior. This model provides an engineering cognitive perspective and thinking method for understanding human behavior and social activities in the digital age.

1. Preface

Both matter and information exist objectively, which is relatively philosophical concepts. Space is the place where entity exists. Physical entities and Information entities exist in their respective spaces and are mirror-symmetrical [1-2]. Through observing physical entities, observer externally observes the recognized part of the information entities from the physical entities and stores them in media.

Human beings are the most active observers. Human brain is a basic memory media of the original out-structure information. Physical space contains many kinds of physical entities. People observe them in different natural and social environments, and draw different conclusions. Moreover, the cognition of similar things will produce certain common conclusions, that is, people's consensus information or public out-structure information. The consensus information can be expressed by equation 1.

\[ I = \bigcap_i I_{oi} \]  

where \( I \) is consensus information, and it is the intersection of out-structure information of each observer.

Before popularization and application of information technology, the public out-structure information of people is mostly regional consensus. Nowadays, digital networks have become part of people's cognitive and memory information. Human brain with limited information processing...
capabilities accesses with the complete digital cyberspace. And it is a new challenge for people's
cognitive habits and action patterns. Therefore, people are urged to rethink some of the original
problems in order to rationally deal with new shocks. This paper starts with the external attributes,
proposes the definitiones of human brain, external brain and public external brain. Also relationships
among the three are proposed. This paper further explores and explains the positioning and value of
human in this historical context.

2. Human brain
This article does not deconstruct the physical structure of brains, but is based on the individual's
performance in social events and life forms to speculate on attributes of human brain from external
phenomena.

2.1 Natural attributes

2.1.1 Biological attribute. Human brain is estimated to contain 5 to 10 billion (10¹¹) neurons, which is
connected by as many as 100 billion synapses, and neurons are the basic information processing unit
[3-4]. The existence of the human brain in physical space has a life time limit. Biological attributes are
the basis of the existence of human brain.

2.1.2 Memory attribute. The human brain has information memory and storage functions. Human
memory is governed by a very rich variety of biological signals, which is the precipitation of
information and knowledge by individuals. Memory function is a basic attribute that guarantees
natural survival of human beings.

2.2 Social attributes

2.2.1 Subjective initiative attribute. Human cognition mainly depends on five senses, the proportion is
about 87% of vision, 7% of hearing, 3% of touch, 2% of smell, and 1% of taste [5]. Different brain
regions corresponded to different functions to process corresponding perceptual information, in
addition to comprising information and knowledge memory, information coding, information retrieval,
etc. [6-10]. Under the regulation of the hormonal system, the brain produces a corresponding
self-perception [11-13]. Human brain has subjective and active cognitive, selection, memory,
reasoning, decision, creation, and ability to govern people's actions. Affected by factors such as genes
and environment, each person will form their own likes and dislikes. This attribute makes everyone an
independent individual.

2.2.2 Dynamic plasticity attribute. Through a large number of research experiments, the number of
synaptic connections, function and structure of human brain are not fixed. They are changed with
behavior, social environment, cultural environment and different life periods [14-17]. Human brain has
dynamic plasticity attribute. Studies have shown that the gray matter associated with spatial cognition
in the driver industry is different from that of ordinary people. Long-term related experience and
training can cause plasticity changes in relevant region of the brain. In a different context, the specific
abilities of the human brain will be gradually strengthened. In the course of time, evolution of human
brain has never stopped.

In summary, people recognize and judge on information space, make decisions and act on physical
space. The human brain is a dynamically evolveable biological entity with information out-structuring,
information processing and information enabling. It is the core hub for completing the closed loop
between physical space and information space.

3. External brain and public external brain

3.1 External brain
According to the individual's will, such as bamboo slips, pottery tablets, books, etc, the external brain is a physical media that statically stores out-structure information. In addition, due to differences in languages, interests, and knowledge categories, external brain stores block consensus information generated by a specific population.

3.2 Public external brain
The emergence of information technology such as the Internet and the Internet of Things has revolutionized forms of traditional information encoding, compression, storage, and dissemination. The universal application of unified electronic coding, optical speed network transmission, mobile communication and other information technologies enables human brain to communicate with digital information space in two-way. People can simultaneously acquire instant information generated in other areas. Digital information space is like a public external brain with high information synchronization. Based on this, public external brain is defined as a digital ecological space that uses information technology such as sensors and Internet as the information infrastructure and human subjective activities as the mainstay to memorize complete information of human beings.

3.3 Relationship among human brain, external brain, and external public brain
The three have great differences in different attributes. Firstly, human brain and external brain have limited and islanded attribute in information storage. As of 2007, human technology can store about 251.5 EB of compressed information [18]. Humans have thus evolved from physical evolution (physiological evolution) to physical evolution and information genes (cultural evolution) co-evolution. Secondly, human brain has subjective initiative, while external brain and public external brain rely on the will of the person to passively remember and update information. Finally, human brain has a mechanism of forgetting. This positive self-adjustment is a unique information processing capability of the human brain, and has important reference value for dealing with digital information overload problems in the future. Then, table 1 summarizes the relationship among human brain, external brain, and public external brain.

| Existence attribute | Biological attribute | Material attribute | Material attribute |
|---------------------|----------------------|-------------------|-------------------|
| Storage attribute   | Limitation           | Limitation        | Infinite          |
| Information category| Consciousness        | Refinement        | Coarse grain      |
| Coding attribute    | Biocoding            | Language, image,  | Digital coding    |
|                     |                      | etc.              |                   |
| Connectivity property| Islanding            | Islanding        | Integrity         |
| Social attribute    | Exclusivity          | Publicity         | Publicity         |
| Memory attribute    | Dynamic memory       | Static memory / no| Dynamic memory /  |
|                     | forgetting           | forgetting        | no forgetting     |
|                     |                      | mechanism         | mechanism         |
| Active/passive attribute | Initiative    | Passive          | Passive           |

4. The influence of external brain and public external brain on people
External brain improves people's cognitive speed in the vertical (same category) knowledge system, yet public external brain makes it possible for people to have a holistic cognition (rapid cross-category cognition). In order to further clarify changes in people's cognitive and action patterns in the digital age, this paper proposes a cognitive and action model as shown in Figure 1. Based on graphical representation of logical reasoning, this model has a certain universality in both micro and macro perspectives, provides a theoretical reference for engineering design of human social behavior.
Figure 1. Human Cognition and Action Model in the Digital Age

Public external brain compresses space and time to a point under the physical space, namely the human brain or information terminal. Since then, individual's intellectual power has been amplified by technology. Human cognition and action are not only about personal results, but also epitome of the times in social development. With the help of public external brain, the various elements of society can achieve overall synergy and achieve maximum benefits of social development. The ability to use external brain and public external brain determines the pace of human and social progress. It is also the purpose of this paper to sort out basic problems of human brain, external brain, and public external brain.

5. Reflections on technological change

In order to make up for limited abilities of human brain, people have turned on technological innovation again and again. Every time we experience a technological innovation, we need to re-cognize the source of problems as much as possible, so that we can respond rationally and correctly impacts of technological change.

At present, artificial intelligence, deep learning and other technologies can help the machine to learn and improve machines themselves. Machine system capabilities can quickly surpass individual abilities, which is an unprecedented shock for social development and human development. However, there is no clear consensus conclusion on how to achieve a norm and standard in intelligent implementation. For example, should the machine be self-aware? In the face of the improvement of artificial intelligence social production capacity, how should people respond and find their own positioning and value under the social system? How to achieve a new balance among people, things and nature? It is even necessary to ask what for people. Of course, if human beings want to dominate the tools, while enjoying the convenience brought by technology, we must think and then solve social problems brought by technology from a deeper perspective, or problems given by themselves.

6. Conclusions

Public external brain has revolutionized traditional ways of cognition and action. People can carry out holistic cognition, judgment, decision-making and action. This change not only makes individuals themselves quickly recognize and reduce individual learning costs, but also reduces social resources such as communication costs needed to promote social development. Public external brain makes it possible for people to accurately integrate holistic cognition and action, and is a powerful tool for solving human public problems.

With the gradual completion of public external brain, human beings are standing at the turning
point of social development. After a long repeated revision and accumulation of human knowledge and experience, it is finally possible to grasp the integrity. In this process, people will create more value and open up more new value space under the whole.

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