

Softcopy and Hardcopy as an Information Carrier: Whether or Not Existing a Difference in Interaction with Human Brain

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Abstract

We have examined how influence in brain action to thinking and understanding by seeing hardcopy and softcopy with use of IQ test method. In general, the sense of fatigue in softcopy working may be deeper than in hardcopy working. The hardcopy working in paper and oral answer methods indicates higher IQ than that of softcopy. It can be clarified by using IQ test problems that the difference to human interaction between hardcopy and softcopy as information carrier perception and thinking exists generally.

Introduction

Digital information technology is deeply and widely penetrating into our personal and social life in last decennial. Therefore, many persons are forced to contact with visual display terminal (Softcopy) every day and can get information by seeing and reading the softcopy and can communicate mutually. The softcopy as a new information carrier is the visual display by light emitting or light source image display. On the other hand, the hardcopy as an old information carrier, which have an inked image on paper gives the reflection image by white light illumination and have been intimate and friendly with human for a long time. Does a difference exist in interaction with human brain or in thinking action at two information carriers? This is a very interesting problem in imaging technology. As a primary approach to this problem, we would try to use intentionally the problem used in IQ test method for both left brain and right brain to clarify the difference between softcopy and hardcopy for perception and thinking of human.

IQ and Human Brain

IQ is an abbreviation of Intelligence Quotient and the specified data value to intelligence, which now may be an ambiguous concept. The value of IQ is one of the indexes that indicate an intrinsic or latent ability of human, but not the measure that these abilities can be purely evaluated, because other factors, for example, ability only obtained

through experience and, study, may be contained in IQ values.

Fig. 1 shows the functional activity of the brain. There are right brain and left brain in human brain and is the functional difference for each brain. Right brain is the control center for mind activities such as general intelligence for space, intuition, hunch, rhythm, music, art, physical, response or activity, synthetic and prolific thinking and so on. On the other hand, left brain is the control center for a mind activity such as special intelligence for memory, language, time, number, calculation, logic, analytic and convergent thinking and so on.

Now we have each IQ problem to right and left brains. We would try to investigate the difference of human effects of softcopy and hardcopy by using IQ test method.

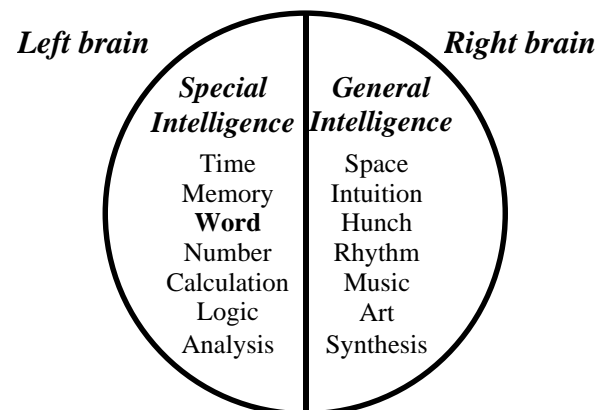


Figure 1. Mind activities of the right brain and the left brain.

Experimental

Subjects

Subjects were 24 persons for paper answer method and 24 persons for oral answer method (total 48 persons). The subjects were age of 21 to 24 and had experienced the visual display terminal (VDT) working.

Equipment and IQ Problems

Table 1 shows the specifications of the CRT display used in this experiment. Examples of IQ problems are shown in Fig. 2. Right side problem is for right brain and left side is for left brain. IQ problems were classified in two groups of A and B and the number of problem in each group was 60.

The problems were shown as softcopy images by CRT display and were given as hardcopy images printed on paper. The image size of each on hardcopy same.

In experiment, the room light was white fluorescent lamp and all windows of room were covered by black curtain. The illumination on working desk was about 500 lux.

Table 1. Specifications of the CRT display used in this experiment.

Screen (size)	17Inch Color Monitor (327mm×243mm)
Resolution	1024dot×768line Dot pitch 0.25mm
Refresh rate	75Hz
Luminance	120cd/m²

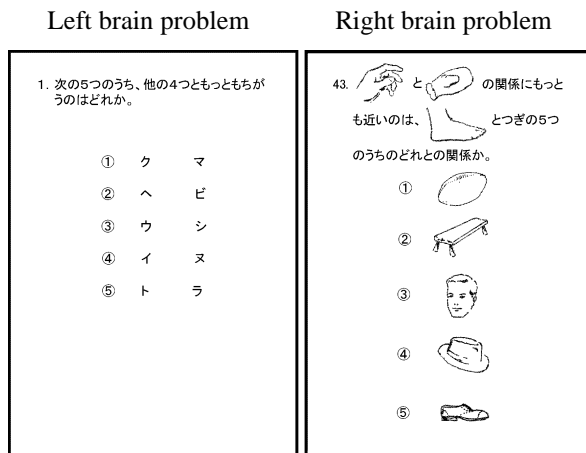


Figure 2. Examples of IQ test problem.

Procedure

Before test starting, each subject was explained for work flow, answering method, careful points and exercise. The experimental work flow was the following order, that is, explanation, the first half test, rest, the later half test and inquiry. The rest time was 15 minute. Table 2 shows experimental procedures at 4 groups, and arrows in the table indicate order of the procedure. For example, the 6 persons of group 1 first one answered with hardcopy and problem A and then with softcopy and problem B. The procedure of Table 2 was applied to paper answer group (24 persons) and oral answer grope (24 persons). Fig. 3 is a photograph of experimental scene.

Table 2. Experimental procedure at 4 groups.

Group	Hardcopy	Softcopy
1(6 pasons)	A →	B
2(6 pasons)	B ←	A
3(6 pasons)	B →	A
4(6 pasons)	A ←	B

Paper answer group-24 persons
Oral answer group-24 persons

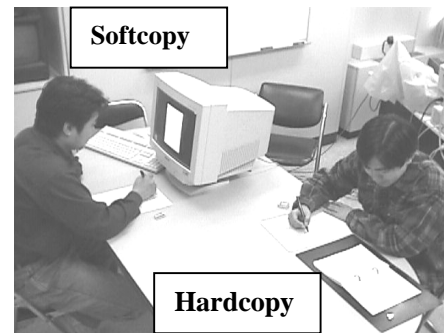


Figure 3. A scene of experiments.

Results and Discussion

Inquiry to Impression in Working

First, we asked working over person "Which human interface are tired for you". This is the question about subjective fatigue. Fig. 4 shows the comparison of fatigue in two interfaces. We can see 50% in paper method and persons of 76% to be tired with softcopy in oral method.

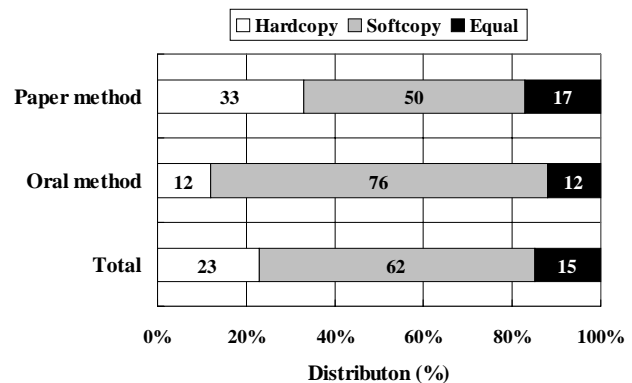


Figure 4. Comparison of subjective answers on fatigue in two information.

Second, we asked "Which do you feel more easy of thinking". This is the question about subjective easiness of thinking in the two interfaces. Fig. 5 shows the results of the asking. The 58% person in paper method and the 71% person in oral method answer more easy thinking to hardcopy. This is to be expected, because same result is mentioned in the paper that VDT and paper text in proof-

reading were compared for speed, accuracy and fatigue by R.T.Wilkinson et al¹⁾. It will be suggested that the close relation between easiness of fatigue and of thinking in two interfaces.

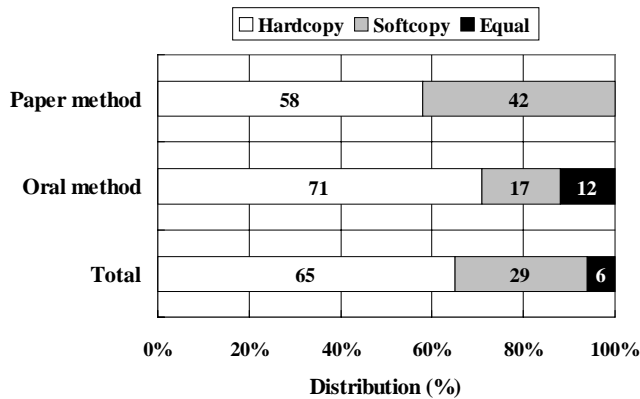


Figure 5. Comparison of subjective answers on more easy thinking in two information.

Comparison by IQ Value

Table 3 shows average value and standard deviation of IQ. The average IQ value for hardcopy is a little larger than that of softcopy. The standard deviation of hardcopy is smaller value than that of softcopy. Percent distribution of number of person getting larger IQ value for hardcopy and softcopy is shown in Fig. 6. Hardcopy test in both paper and oral method indicates larger IQ value than that of softcopy. It may be suggested from Table 3 and Fig. 6 that on the whole, hardcopy for human will be suitable for thinking by seeing and reading.

Table 3. Average and standard deviation of IQ value.

	Hardcopy	Softcopy
Paper method	129.9	126.8
Oral method	129.0	127.2
Total Average	129.3	127.0
Standard deviation	9.11	9.46

IQ Value by Right and Left Brain Problem

The difference of the correct answer rate between hardcopy and softcopy in both brain problems is shown in Fig. 7 (Right) and in Fig. 8 (Left). The correct answer rates for both brain problems in both answer methods are higher in hardcopy than that in softcopy. The difference of correct answer rate in hardcopy and softcopy is higher in paper method than in oral method. It may be supposed from this data that there would be psychological effect in oral answering.

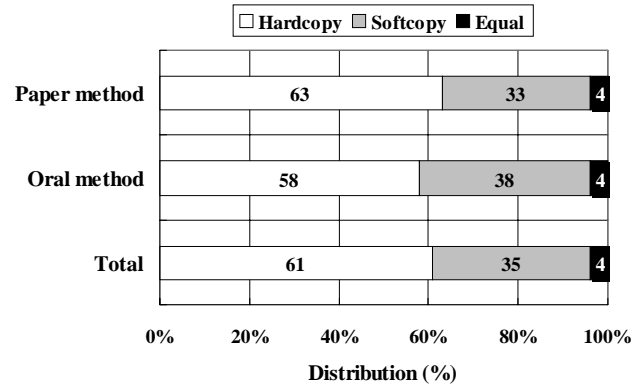


Figure 6. Number of person getting larger IQ value.

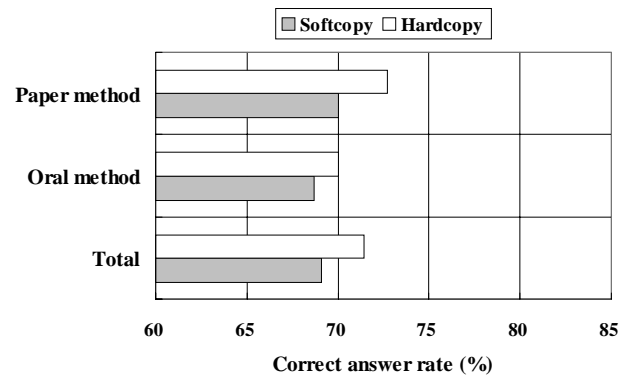


Figure 7. Correct answer rate of the right brain problem.

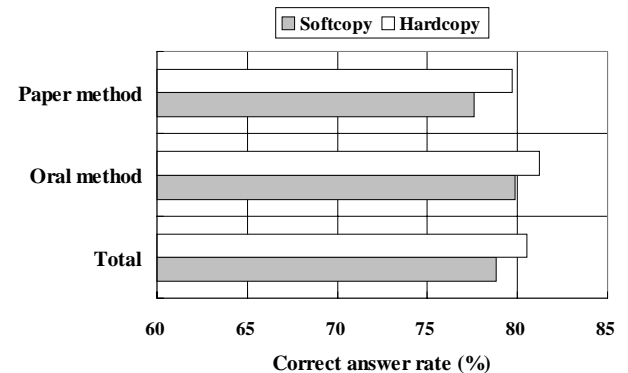


Figure 8. Correct answer rate of the left brain problem.

Conclusions

We have surveyed how influence to reading and thinking ability of human in hardcopy and softcopy by using IQ test method.

- (1) In general, the sense of fatigue in softcopy working may be deeper than in hardcopy working.
- (2) The hardcopy working in paper and oral answer methods indicates higher IQ than that of softcopy.
- (3) We can not find the large difference between right brain problem and left brain for both human interface, but some difference of IQ between hardcopy and softcopy

may be found in left brain problem and this means to denote higher IQ in hardcopy working.

It can be clarified by using IQ test problems that the difference of human interaction between hardcopy and softcopy as information carrier for perception and thinking exists generally.

References

1. R. T. Wilkinson and H. M. Robinshaw: "Proof-reading: VDU and paper text compared for speed, accuracy and fatigue",

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Biography

He entered Tokai University, 1995 (Department of Electro-Photo-Optics). He graduated from Tokai University, 1999 (Department of Electro-Photo-Optics). He entered Graduate School of Tokai University, 1999 (Study of image technology at Dept. of Electro-Photo-Optics). He is interested in difference in information with brain of human interface.