What impact does an illustrated article have?
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How we process illustrations

Today we use more and more illustrations in printed matter assuming it helps to clarify the meaning. My idea was to find out how people recognize, remember and understand contents in illustrated articles compared to those without pictures. This kind of studies have been made before (for instance Standing 1973, Paivio & Csapo 1973, Paivio 1986 and 1991, Dwyer 1976, Anglin & Levie 1985, Hannus 1996, Mikkilä-Erdmann 2002), but I was especially interested in the overall impact of illustrations over long time periods. Why have so many studies arrived at the conclusion that illustrations interfere or that they are inconsequential?

The basic question is how we perceive and think. What is the role of mental images in the process? There are several cognitive theories about it. According to Pylyshyn (1999) all thinking is propositional, while Kosslyn (1996) claims that imagery rather relies on depictive representations. Thinking carries visual images, which are different from the rest of the semantic components. Dual coding theory by Paivio (1986) is an intermediate theory between the two: images may also be coded verbally, if there is enough time. A link may be created between visual and verbal representation in the memory: when one of them is activated, it may arouse the other one, too. Two codes are better than one.

In conveying the meaning of an image there are several steps: recognition, understanding and recollection. We can recognize, even if we do not identify, and remember, even if we do not understand. Cognition is not a neutral system of perception, but rather, always embedded in functional contexts, directed and altered by motivation and emotion (Dai, 2004). According to Dake (2004) significant aesthetic perception begins before conscious awareness.

I have applied semiotics in my thesis by borrowing some useful concepts like semiotic levels (Morris 1971, Goldsmith 1984), because they offer a good tool in analysing illustrations and their different content levels: material, meaning and context. Syntactic level of the image is the external appearance, which exists regardless of the viewer. Semantic level gives it a meaning and pragmatic level sets it in context. If we can create illustrations that help us understand and create effective imagery, we are a step closer to our goal.

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1 "Although we cannot yet say definitively how visual information is stored and processed in the brain, considerable progress has been made in such research. One line of research hinges on the idea that much of the visual information we store in memory can be recalled in the form of visual mental images, and thus the study of visual mental imagery can reveal the nature of internal visual representations."

To study the assimilation of whole illustrated texts I made two tailored articles: one about Plato's utopia and the second about Acupuncture. Both of them consisted of a folded A3-paper pages and included illustrations that varied from colour photographs, paintings, graphs and b-w drawings to abstract paintings. Illustrations with and without captions were used, and both articles also had a text-only version of the pages. After the first test article (Plato) some illustration types were changed in the Acupuncture article. Maps with names were replaced with a diagram and four cartoon-like drawings.

Two different test groups were chosen: the results collected from art students and professionals were compared to those from law students. There were 91 test subjects altogether, and the groups were tested separately. After reading the article the test subjects were asked to write down all they could recall about it and later to write and draw answers to specific questions.

Ten weeks later four slides of original illustrations were mixed randomly with more or less equivalent variations of them plus five 'deception' pictures, 25 slides altogether in each experiment. Each slide was shown to readers of the illustrated versions for ten seconds only, with a ten second interval between each one. They were instructed to answer (yes or no) whether they had seen the picture in the article. (Figure 2)

At the end of these tests, the articles were returned to the readers of the illustrated version and the subjects were asked to select the most attractive ("most beautiful") and the least attractive ("ugliest") illustration in them. This was to find out whether aesthetic considerations can affect the memory. Results of memory tests were then cross referenced to the aesthetic ratings. Estimations of emotional response to the articles was also indicated by subjects using a scale from 1-5.

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2 This was because the results showed that maps with place names were too difficult to remember. See the test articles in pages 99-106 , full text pdf: acta.uta.fi/haekokoversio.php?id=11245). Hatva, Anja. "Merkityksen välittäminen kuvan avulla." (2009) [English abstract "Transmitting meaning via illustrations", pages 358-359]

3 See the variations of all the test pictures on pages 168-173 of the dissertation.
Figure 3. Structure of the study. In the first experiment there was an exception: after reading the article, a small group of professional artists were asked to produce an illustration about Plato's ideal society (instead of a written answer). The rest of the experiment was carried out as in other groups. Ten weeks later they took part in the same experiments as the other groups. Normal conditions were followed in experiment 2, where the subjects were only students.

People with text-only versions were given the same tasks and asked the same questions with the exception of those concerning the pictures. Instead Plato-article readers were asked to describe Plato as a person, and readers of Acupuncture-article were to write and/or draw about yin and yang-theory on the basis of the article. Research structure is shown in figure 3.

**How can you count thoughts?**

For analysing test subjects' free recall the texts were set out as meaningful propositions (i.e. phrases like "Plato's ideal state was a class society"). Their memory of the texts was then measured by counting the propositions and illustrations they managed to mention and also by setting questions about the essential contents. The subjects’ drawn answers were judged on the basis of content accuracy. Nature and influence of mental images was deducted by studying the participants’ drawings, recollection, and their answers to the set questions.

The overall effectiveness of each illustration in the article was also analysed and reported separately by an average recall percentage, aesthetic estimation, impact as a clue\(^4\), recognition rate\(^5\) and effectiveness in reminding the reader of the text context.

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4 Four drawings per article were delivered on a paper to the subjects and they were asked to write down all the content that they could recall relating to the drawing.
5 Four original illustrations per article were chosen into the recognition test ten weeks later. Other illustrations are not reported by this criteria.
Content questions were designed to estimate the general understanding of the article and recollection of essentials over an extended time period. For instance the subjects were asked: "What did Plato mean by the equality of women at work?" "What is the western viewpoint on acupuncture?"

**Quantitative data shows better retrieval for text readers**

As there was no significant discrepancy between the artistic groups and the law students concerning their recollections, their results have been combined and the averages are calculated from these combined results. The recollection results can be seen in Figure 4.

Although the illustrated articles were regarded both easier to read and more comprehensible than the unillustrated text, the readers of the illustrated text remembered fewer propositions, both immediately and after ten weeks delay, and gave less qualified answers to three of the four content questions. Average answers from all the groups were rated from poor to a slightly above average in quality and they were mostly “atomistic” in nature.

The test subjects forgot immediately almost half of the written material, and ten weeks later they remembered only about one-fifth of the original article. They recalled a lot more pictures than text, initially three quarters of the original number of illustrations and after ten weeks still more than 60%.

On the other hand, some of the written material was very poorly remembered. Names, terms, years and other numbers were forgotten almost immediately: all groups recalled less than one fifth, and after ten weeks most of it had totally vanished. A lot of mistakes were made with names and time was incorrect.

Images are remembered quantitatively well, but the recognition is even better: nearly four-fifths of pictures in both articles after ten weeks (Figure 5). There were a lot of individual differences in recollection, but in recognition there was no remarkable discrepancy. In the Plato-test 19.7 pictures out of 25 were recognised on average and in the Acupuncture-test 19.6 pictures. An interesting finding, however, was that among the worst recalled pictures most frequently were the originals.

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6 Easiest to recognize of the four different types of illustrations in both articles were simplified symbols, then photographs without background, naturalistic water colours and lastly abstract pictures.
Figure 4. Recalling propositions and illustrations in test articles. Top bar represents all remembered propositions, middle bar essential claims. Lowest bar represents the amount of recalled illustrations. On the left are the results of the illustrated articles, on the right the unillustrated condition. It is assumed that in the Plato-article there was a maximum of 60, and in the Acupuncture-article 100 propositions. There was 11 illustrations in the Plato-article and 10 in Acupuncture.

Figure 5. Average recognition of illustrations compared to recalling them. Ten weeks after reading the article a recognition test was conducted.
Figure 6. Original illustration with a caption (upper left), and its interpretations by art students. Some of the drawings show how unclear their mental images have been. The subjects were asked a question: Did the person in the picture wear a headdress? Altogether, one quarter of the answers were wrong, ten percent could not remember and the rest was mainly guessing. One quarter of the art students and only one of the law students could remember the exact timing of Ming-dynasty, when mistakes ± 50 years were accepted. Even 2700 years B.C. was suggested.

**Remembering pictures**

Although illustrations were remembered well when listed, their details are not recalled accurately. Test subjects did not necessarily remember even the number of people in the illustrations. For example, subjects often answered there were about four persons in the picture of the cobblers workshop. Interpretation errors were observed, particularly in connection with images that did not have captions.

Misinterpretation can start to develop if the reader does not understand the circumstances in the picture. Imagination creates new stories: a law student remembered
three figures in the illustration 'cobbler's workshop'. Two of them were women. The third person was a male who was sitting next to a woman. There was a spa from ancient Athens in the picture. The illustration was colourful. For instance there were palm leaves, different kinds of fruits, tables and chairs." After ten weeks he wrote: 'There was a coloured illustration at the back of the article showing ancient upper class Greeks having some kind of orgy.' (Figure 7)
Over time, the mental image is transformed and weakened. A ten-week interval appears to cause drawings to simplify and become more fragile. (Figure 8) Indeed, they seem to go through the same type of transformation as written texts in some studies\(^\text{7}\) by Marton et al (1983).

Details are easily ignored. For instance, I asked subjects to draw the statue of a philosopher from the original article (Figure 8) without a model and asked what he was holding in his hand. There was more false than correct answers: only 17% were correct, 24% could not remember or did not answer, 59% answered incorrectly immediately after reading (N=29). I also asked if the statue had footwear, and again, 59% of the answers were inaccurate. There was no caption explaining the illustration, but many of the readers had interpreted it as representing either Plato or Socrates, because there was a description of the philosophers in the main text. The ones that thought it was Socrates stated he did not wear shoes because it was written in the text that he always lectured barefoot. People had a tendency to name the statue as somebody although it was just an anonymous statue of a philosopher. Even Aristotle was suggested although his name was not even mentioned in the article. Mental images seem to be modified according to the individuals background knowledge and expectations. The same type of results were found also with the Acupuncture-article.

After ten weeks the 'philosopher' illustration was the best remembered (100%). When asked to rate the illustrations, it gathered the most 'beautiful' ratings (32%), no 'ugly' ones and was the most effective as a reminder (72%). Efficiency in remaining the text context was ambivalent because there was no caption. The high scores in recalling the statue can also be accounted for by the repetition in the test condition, because the participants were asked focused questions concerning it and they were also required to draw it. Less successful illustrations were often small and black and white.

\(^{7}\) Marton et al (1983) studied retrieval of text contents in the long term, and noted that a story was simplified and even fragmented in a year if the reader did not originally understand the "red thread" of it.
Figure 9. Original picture from the Plato-article and some drawings of the statue by a professional artist, an art student and a law student. 'What was the statue holding in his hand?' Examples of incorrect answers to the question were: a book, a plate, a paper scroll, flap of a toga, cup of poison. (The right answer was a rod or a stick.)

Figure 10. When listing the pictures after ten weeks the worst ratings in recollection were found concerning illustrations "crown" (13 %), "needle pack" (18 %) and "vignette" (18 %), while the average percentage of recollection for the illustrations was 60 %. The crown also was found most unattractive by 9 % of the readers, and only 13 % of the subjects remembered its connection to the text. It helped as a reminder in only a few cases. The "needle pack" (in the middle) did not have a caption, but it was explained in the main text that needles used in Finland are disposable, which 24 % of the readers remembered (average of recalling of the text context of pictures in this article was 14 %). This picture got no aesthetic statements, the "vignette" topped the series with a 29 % "unattractive" -rating. The latter also had no caption, although it was placed next to a subtitle "How does acupuncture work?".

Watching with the mind's eyes

During the first experiment I also asked about the strategy that the test subjects were using when recalling their list of the illustrations. About 86 % of the participants (N=49) reported they used a visual strategy where they were 'viewing ' the pages in their mental images. Picture 11 proves that at least some of them were very accurate.

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Impact of the creative process

Test subjects reading the unillustrated version described Plato on the basis of his deeds. They used more abstract than concrete attributes like radical, creative, observant, reflective, non-democratic, wealthy, intelligent, cunning, superior, faithful, a dissident, dreamer, noble, aristocratic, industrious, critical, idealistic, ahead of its time, wise, learned, dashing, independent, audacious, active, purposeful, ambitious, hard-nosed, liberal. Some readers of unillustrated article also created drawings from their imagination without a model. (Figure 12)

Figure 12. Drawings without a model by an art student during the first experiment and after ten weeks. The text in the article described the sign: "The symbol is a circle divided by an S-shaped line. Yin is the dark area with a light patch, yang has a dark spot on a light background." Of course the student is familiar with the sign from earlier experiences. Even so, creating the drawing might have interfered with his concentration on the content, because he made factual mistakes with his recollection.
Figure 13. An example of results of a design task for professional artists. They were asked to paint an illustration about the theme 'Plato's ideal state'. This illustration was made by an artist who got to read the 'unillustrated version of the test article. He did quite well without any pictures, leaning on his own mental images, with his art school and cultural studies background. (Illustrator: Hannu Hyrske)

Artists did, of course, make the best looking drawings, but when I studied their factual content (hair, position of hands, details etc.) there was not a great difference. Their special task, illustrating the ideal state of Plato, produced very individual works of art, no matter if they had been reading the illustrated or text only -version. All works were independent and personal (Figure 13). I compared their illustrations to the written recall they gave ten weeks on. My expectation was fulfilled: they did better remember facts they had included in their art work and had forgot the things they had omitted.

Aesthetic selecting
Both the 'most beautiful' and the 'ugliest' -ratings accumulated by some of the images. These images are characterized by the fact that the most attractive images are often big and in colour. Small, black and white illustrations did not wake any judgements. They were also the ones that people easily forgot. This implies that aesthetic evaluation has a cultural nature, because subjects widely agree. Freudian theory of the search for pleasure and avoiding unpleasant experiences also gets some support (Figure 14).
Figure 14. Aesthetic estimations and spontaneous remembering of illustrations after ten weeks.
(The illustrations have been given short names.)

**Conclusions and afterthoughts**

Images do not automatically improve the dissemination of information, because those who read the 'text-only' article remembered the content better. In this study not all illustrations were even meant to be ideal: there were purposely some distracting images, like an abstract picture. 'Abstract image had no connection to the story' was the idea of at least 60% of the statements. One third forgot it right away, over half of the readers had wondered about its purpose, and the rest tried to attach a meaning. Many respondents also included an aesthetic evaluation in their answers. Anyhow, those who had the illustrated text experienced it more facilitating to read. Perhaps reading an illustrated text was found to be more pleasant.

Images have potential, as the amount of pictures was remembered at over three times the amount of text even after ten weeks. Some pictures were clearly remembered better than others. There are big differences between individuals in recalling images and text, which may be explained by background and motivation.
Effectiveness of the image depends on the individual features of the illustration: both syntactic appearance and semantic content are important. Pragmatic interaction between image and text is essential. The text has an important guiding role in understanding the picture. Illustrations focus attention, sometimes 'stealing' it.

Why were the details of mental images so unclear? Our view of the environment is gathered by rapid eye movements. We see what is necessary to achieve the goal\(^9\). If the images are not syntactically recorded with photographic precision, how could the exact matching be done at all? Mental images seem to be sketches that the brain builds up on the basis of percepts, logical deduction, guessing and creative thinking. The mind modifies meanings closer to one's own attitudes and beliefs, which supports the constructivist learning theory.

Quantitative data supports the picture superiority theory\(^10\). Pictures were recognized more than 80% correctly ten weeks after the reading. The original images had worst recognition rate, which might indicate an exclusion strategy. Maybe ten seconds time was insufficient for comparing almost similar mental images. Maybe it means that there is not enough detailed data stored in the long term memory? Intra individual differences were not common in recognition, while they were common in subjects' ability to remember content. Perhaps the rapid recognition is an important inherent basic function of the human perception system?

Recalling content depends on the background and interest of individuals: they remember different substances depending on their orientation and age. Attitudes modify memories. For instance, in the first test an art student, relying on a diagram, was rather clearly able to explain the nervous system and main principles of acupuncture. *The story removed bias, because it was discussed medically from a western point of view*, he writes, but after ten weeks he had returned to his earlier attitudes stating that acupuncture is phoney or regarded as alternative cure. It is difficult to change old beliefs and conceptual misunderstanding\(^11\).

Overall, the answers to content questions were showing 'atomistic' thinking\(^12\) of the kind represented by the test article itself: the information was fragmented. Some of the answers from the readers were superficial and were mostly concerned with the story's appearance, but many subjects also began to contemplate the theme, such as how Plato's ideal state would work today, or how 'free' women really were in ancient society. Several students started to consider acupuncture as an option for themselves or their relatives' health disorders.

What really happens to the knowledge when time passes? Verbal as well as visual information declined, became generalised and the details were forgotten over time. Sometimes image and text were recalled separately, which advocates double coding theory. Some items were remembered better: interest, experience and motivation direct attention and storing information. The viewer constructs logical mental images from visual and verbal fragments. Thinking is a "multimedia", where all senses participate in creating meaning. Understanding is a process where several factors influence the outcome (Figure 15).

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9 Vogel et al: Only part of the fixations is saved, and up to 99% of the field of vision may go unnoticed. (2001).
10 Standing (1973) found that subjects presented with 1000 pictures at 5 seconds each reached a recognition of 880 "vivid" pictures, 770 normal pictures, but only 650 words as slides (62 %).
12Expression comes from Marton et al. (1977)
**How can a designer improve performance?**

Design has a lot to learn from other sciences like cognitive psychology and semiotics. You have to follow the general laws of perception and thinking. The architecture of human memory has to be taken into account\(^\text{13}\). Visual communication is just one media. Comprehension is the objective of any form of communication. Consequently, the importance of careful planning becomes evident.

People adopt new material according to their former knowledge. A designer can best influence on the field of syntactic expression. The aesthetic appearance of the design may at least exceed the threshold of the reader's interest. Syntactic features as well as semantic content can direct attention: large, coloured, or 'different' pictures are noticed. Impressive or relevant content can remain in the memory. Captions can guide perception and help in understanding. Using illustrations can also ease overload of work memory. By planning pragmatic relations between image and text critically you can avoid unnecessary illustrations. Type of illustration must be selected to suit the task and the target group, supported by appropriate text.

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\(^{13}\)Kosslyn S. M. 2006: Graph Design for the Eye and Mind. (2006)
References