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The New Applications of Mind Mapping in Medicine

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Introduction

The current most convincing evidence suggests that mind mapping is superior to traditional linear text in communicating complex information. This is asserted from the points of view of memorization [1-4], productivity [5,6] and error reduction [7,8]. While the effect of mind mapping on patient care is indirect instead of direct, its use has very important consequences on the patient's wellbeing and safety. If physicians use the best drugs and treatments, why shouldn't they use the best way of communicating with patients? Mind mapping has been used in healthcare to a certain degree, but the lack of progress in the area of mind mapping automation has slowed down its use in medicine and nursing. In recent years the development of consistent solutions [9] has permitted the creation of multiple applications to increase the productivity of nurses and physicians, improve the communication between nurses, physicians and patients and improve patient safety and quality of care.

This article presents the scientific bases of mind mapping and some examples of real applications of the mind mapping technique for patients, nurses and physicians. Most of these applications are automated. Those looking for a deeper understanding of the mind mapping technique and a historical introduction to the subject, can find it elsewhere (Guerrero and Ramos [10]).

The science behind mind mapping

Some of the advantages of mind mapping over linear text are due to the use of images in mind maps. The origin of the human neocortex can be traced to reptiles [11] during the Carboniferous Period (359 million years ago). During the transition from the Triassic to the Jurassic periods (200 million years ago), the early mammals had a neocortex composed of six layers. The anthropoid group of primates is at least 80 million years old [12].

The oldest written language dates from 3100 BC [13]. This is what we can consider the first use of linear text. Our brain has had much less time to evolve and improve our capability to analyze and memorize written linear text.

Evolution is probably the main reason why mind mapping is much better than linear text at the time of analyzing complex information. Our brain processes images a lot faster than text. The human brain has had no time to evolve a dedicated mechanism for reading. Linear text is too recent and until last century it concerned only a very small fraction of humanity to have influenced the human genome. Learning to read must involve a 'neuronal recycling' process whereby pre-existing cortical systems are used of recognizing written text. The visual word form area (VWFA) is a region of the fusiform gyrus that is involved in identifying words and letters from lower-level shape images [14].

In 1960, Sperry, Bogen and Gazzaniga started modern split-brain studies. These experiments produced much of what we know about hemispheric specialization and integration [15]. The left brain is responsible for logic, numbers, words, lists, analysis, sequences and detail. The right brain is responsible for spatial awareness, color, imagination, dimension and holistic awareness. If we only use linear text, we are not able to use most of the characteristics of the right hemisphere. In order to understand completely, we need both the big picture and the detail of information. This means that we only use part of our brain. This must have serious consequences in productivity. Some studies confirm that when task requirements are demanding, performance is enhanced by distributing processing across the hemispheres [16].

When using linear text, it is impossible to gather the big picture unless linear text is extremely simple.

The picture superiority effect Shepard affirms that ideas and concepts are more easily remembered if they are presented as pictures rather than as text [17]. This effect extends to associative recognition [18].

The human brain can detect and process images a lot faster than text [19,20]. The human brain can process an image seen for just 13 milliseconds [19]. Our brain is constantly trying to understand what we see, and is extremely fast when processing images.

The ability to rapidly recognize objects is solved in the brain via a cascade of computations that end in a powerful neuronal representation in the inferior temporal cortex [21].

Short-term memory refers to simple retention of small amounts of information, tested immediately or just after a short time. Working memory is the term used when talking about a system

that not only stores simple information, but also manipulates it in order to perform reasoning, learning, and comprehension [22].

In 1956, George A. Miller established the limit to the working memory capacity in seven plus minus two [23] items of information. This was just a rough estimate of the real value. At the beginning of the 2000s, Cowan did actual research on this issue and found that the adult human can only keep four items of information in working memory [24], and only if the items of information are simple or familiar. We cannot keep complex ideas in our working memory unless they are familiar ideas already stored in Long Term Memory. Osaka [25] used probability theory to predict that the most effective chunking involves groups of three or four items, such as in phone numbers this result agrees with what was found by Cowan.

Working memory capacity can be defined as how many separate concepts can be kept accessible at once, and working memory capability as how well attention can be used to keep a task goal active in the presence of interference [26].

This is another important reason why mind mapping is better than linear text. Linear text contains too many items of information, many more than the limit of four. Our brain finds it impossible to memorize and work with so many items of information. Mind mapping uses the concept of chunking to avoid this limit of the working memory. Phrases or paragraphs of linear text are converted into short phrases or words. This process is similar to breaking down a large goal into smaller tasks.

When working with digital mind maps the possibility of collapsing / expanding branches helps us to be able to work at the level of four items of information. We can navigate the mind map and collapse/expand the information we need so that we can always see the interesting details without losing the whole view. And we can do all of this in the same computer screen. In this way we partly avoid the problems of the limited capacity of our working memory. Web pages have most of the same problems of linear text. When we move from one web page to another, our working memory is rapidly filled with the information in the new web page and we lose the information of the previous one. This effect was clear since the beginning of the WWW. Users simply became lost when navigating in a web site. In trying to solve this problem, the system known as “breadcrumb navigation” [27] was developed.

Attention is another of the main reasons of the superiority of mind mapping over linear text. Our vision system makes a very important use of visual attention mechanisms in order to select relevant information among the enormous amount of visual input that we receive. During evolution, attention has provided fast reaction time to escape from predators. Visual attention has limited the computation needed to the smaller area highlighted by the attentional focus [28]. While in the case of linear text we are almost always limited to the use of controlled attention, in the case of mind maps we can use both controlled and stimulus-driven attention. The stimuli in the mind maps are provided by icons, images, relationships, spreadsheets, topic shapes, color and charts.

The use of linear text creates in readers the need of multitasking every time a reference is made to some information located in previous pages. These shifts in cognitive tasks make readers responses substantially slower and more error-prone immediately after each task switch [29]. Mind mapping does not have this problem because all the information is located on the same page or screen.

In mind maps, text is presented in a logically organized, hierarchical structure. This makes it easier to remember than text placed randomly. This improvement in recall can be of up to 40% [30]. Using this hierarchical structure, we create a simplification in the description of complex systems. “If there are important systems in the world that are complex without being hierarchic, they may to a considerable extent escape our observation and understanding” (Simon [31]).

The use of pictures linked to text can increase attention and recall of health information. Pictures can also improve comprehension when they clarify relationships among ideas or elements of information [32-34].

More reasons to use mind mapping in nursing and medicine

Information overload is an increasing problem in the work of physicians, nurses and patients [35,36]. When trying to make sensible decisions we often have more information than our brain can process. The human brain is a bottleneck that we need to unblock.

Mind mapping is often the best way to create, organize, analyze and display complex information. The fact that we can obtain at least a 15% improvement in recall [1] and more than a 20% increase in productivity related to intellectual tasks [5,6] makes a must the use of mind mapping by physicians, nurses and patients.

Mind mapping not only helps in fighting information overload, it does also help us to prevent communication errors in healthcare. “Premature deaths associated with preventable harm to patients was estimated at more than 400,000 per year” [37] (US only). A substantial part of these deaths are attributable to the excessive use of linear text and the lack of use of more visual techniques.

In general, we should use mind mapping whenever we have to communicate complex information. In medicine, almost anything is complex information. Digital mind maps have a series of generic useful features:

- A mind map is a single compressed file that can be sent as an email attachment or uploaded to a web site using FTP.
- We can see the whole-view and the details of the information in the mind map at the same time.
- Due to the use of the collapse / expand buttons, all the information can be visualized on a single screen.
- The mind map displays in a visual and clear way the relationship between all the items of information contained in it.
- Icons, images, callouts, relationships and other visual elements can be included in the mind map.

- All sort of attachments can be included in the mind map, PDF files, Word files, spreadsheets, charts.
- The information contained in the mind map is machine readable. This can be used in many types of mind mapping automation projects.
- The creation of digital mind maps can be automated and personalized using information extracted from data bases. The mind maps can be generated in several languages.
- Mind maps can be exported and viewed as PowerPoint presentations, web pages, pictures, Gantt charts, spreadsheets, MS Project documents and a number of other formats. Conversely, many of the aforementioned documents can be imported into mind maps giving mind mapping great flexibility of use.

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