Information Processing and Knowledge Representation in Persons with Visual Impairment

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Introduction
Cognition or a mental activity involves the processes of acquisition, storage, retrieval and use of knowledge. Cognitive functions take place at the input, elaboration and the output phases of the mental act. First, the data are received by the senses, next the data are compared with information that is stored in memory and then, the data thus organized are used for learning.

Information is processed at two levels:

a) Preconscious (Input)
b) Conscious (Output)

When the data are processed at the input level, the focus is not on the ‘meaning’, only the physical features of the situation get registered. The processing at this level is often involuntary. For information to become meaningful at the second stage, full attention is required. Thus focal attentive processing is a necessary condition for consciousness or awareness. Blindness, by its very nature, modifies the ways in which blind learners receive, evaluate and respond to information. The major channel of information for a learner with visual impairment (VI) is auditory, followed by tactile and kinesthetic.

The cognitive deficiencies observed amongst the learners with VI are as follows:

1. Perceptual deficits which develop due to the difference between the simultaneous character of visual perception and the successive character of tactile perception.

2. Process of concept formation in learners with VI is dominated by two extremes: extremely abstract verbal notions that have little support in the learners' experience, and extremely concrete tactile images of every-day life objects that possess little potential for generalization. As a result, the middle ground, i.e. everyday concepts that possess a certain degree of generality are under-represented in the blind learners' cognitive repertoire.
3. Some of the cognitive deficiencies are directly related to the predominant methods of education for the blind that almost completely exclude two-dimensional schematic representations of objects and processes such as diagrams, charts, plans and maps. As a result many of the cognitive tools used by regular students remain underdeveloped in the blind learners.

Blindness per se does not hinder the differentiation of mental abilities. Kormi-Nouri (2000) [3] found that blind individuals seem to be limited in the use of visualization strategy.

Jonides, Kahn, and Rozin (1975) [2] found that mental imagery as a strategy is a powerful aid in improving a blind individual’s memory. Tinti, Cornoldi, and Marschark (1997) [4] found that role played by interactive auditory imagery in enhancing learning and memory, is similar to that of interactive visual imagery. Two modalities, visual and auditory, can be partially independent at the sensory and representational levels, and individuals, who are blind, perform well when the auditory modality is involved, but not when the visual modality is required. Tinti et. al. (1999) [5] tested blind adults and found the results to contradict the belief that auditory imagery requires other modalities, such as visual, and confirmed the hypothesis that the two modalities (auditory and visual) are at least partially independent at the representation and sensory levels. If the tests relied on other sensory modalities than visual, mental imagery could be a powerful mnemonic aid for the blind individuals. The results of this study also demonstrated that blind individuals do not hear better than sighted individuals, but are particularly efficient in deciphering complex auditory images.

Following the information processing model, cognitive functions of the visually impaired are considered at the Input, Process and Output phases of the mental act.

**Input**
Sensory register confirms the input of information in the cognitive structure. In case of the visually impaired the input gets restricted due to narrowness of their perceptual field. It is often stated that when one modality is blocked it is compensated by others. The persons with visual impairment get used to such cognitive compensation, as the input of information takes place through the linear successive method of tactile exploration, which is confined to one specific line or element at a time. The loss of information is maximal in this stage for the blind. Even after confirmation of the sensory register, to allow the information to be processed further, the blind have limitation in simultaneous exploratory behaviour. The main difficulty is due to lack of availability of appropriate methods of exploration. Often the only experience that students have with two dimensional tactile materials is that of reading Braille pages, as a result their spontaneous exploration of a page with tactile images repeats the technique of scanning the horizontal Braille lines using one finger. Such a method is absolutely inadequate for the exploration of tactile images. Thus producing poor results and impairing spontaneous exploration as a whole. Sometimes this reductive method of exploration is applied to the three-dimensional objects as well.
Congenitally blind have been reported to perform better on the cognitive tasks demanding attention which they use for negotiating with the environment. Due to the enhanced abilities to pay attention and their dependence on the information extracting auditory processes the blind possess superior sound localization abilities.

**Process**

The processing of information requires three basic psychological processes viz. attention, perception and memory. The information by the blind is processed successively rather than simultaneously using the three psychological processes. The visually impaired, due to their overdependence on tactile modality, find difficulty in spontaneous comparative behaviour directed at new tactile images. Spontaneous comparison is observed only with well-trained objects as pages of the Braille text. With sub-vocal rehearsal (inner voice) and storage in auditory-verbal imagery, they rely on motor systems and articulatory kinesthetic processing.

Since the new information is decoded using only auditory and tactile modalities, often deficits are observed due to inadequate coding and recoding of the information. Even when the correct codes and recodes are assigned to the incoming information, at the time of decoding it, they may not remember the actual code which was recoded for the purpose of retention, hence the loss of information.

The visually impaired largely depend upon rehearsal as a control process rather than chunking and coding. They require elaborative rehearsal subjecting the new information to deeper processing. The learning material has to be meaningful and contextual for better retention.

**Output**

The output is measured through retrieval of information. As the visually impaired have difficulty in creating and storing a well integrated mental picture, their responses are often characterized by ego-centricism. They need special training to perform the tactile tasks requiring perceptual transport.

In order to retrieve the information they largely depend on oral and tactile representation. The successive nature of processing information and that too through tactile exploration causes difficulty in organizing and representing knowledge at the time of retrieval.

Ausubel [1], in his “meaningful verbal learning” theory has postulated that the material that is meaningful to the learner and is verbal in nature is learnt faster. It is the ability of the learner to establish a link between the new and the already learnt material. The strength of the anchor that connects the new and the old material determines how organized and stable the learning would be. In order to provide ‘anchorage’ between the new and the old learning experience, the learner draws information from the memory store house that contains unlimited information.
The authors interviewed some adults with VI who are professionally well settled. The visually impaired subjects expressed that they largely depended on their memory while learning and understanding a new material. They depended more on top-down (cognition-driven) processing than bottom-up (data-driven) processing.

Since, the input amongst the blind is only through the non-visual channels the bottom-up processing is more effortful and conscious. Hence, the focal attentive processes are at their optimum. Therefore, the knowledge that they construct is more individualistic and directed by “integrative reconciliation”[1], rather than “progressive differentiation”[1].

Thus, their learning becomes more deductive than inductive. As learning of the semantically related material is faster, the blind subjects also reported that while learning a new content, they used the strategies that would add to the semantic value of the content. The control processes that were used by the blind were more person-mediated than content-centric – they relied more on the control processes which had yielded positive results in the past for them. The control processes used for different types of learning material determined which level of processing was required for that particular information. For example, majority of the blind adults interviewed, reported that they depended more on rehearsal than any other control process such as coding or chunking. They did use coding and chunking but mostly for the purpose of elaborative rehearsal. The subjects depended largely on rehearsal strategy for retention of new information. Like the sighted the persons with visual impairment also process information at two levels – shallow and deep. At shallow-processing, the initial preconscious identification process accesses the memory traces of the input stimuli and those that are semantically related. At deep processing, a conscious and attentive identification process takes over that facilitates the recognition of the new stimuli and inhibits the recognition of the other irrelevant stimuli.

Thus their capacity for selective attention gets enhanced and they are able to store and retain the acquired information in an organized manner. As a consequence, the visually impaired require deep-processing for the same material for which a sighted individual would require shallow-processing. Hence information once memorized remains indelible (memorable) for lifetime amongst the visually impaired.

**Field Study**

**Sample**
Eight visually impaired persons in the age range of 20-60 yrs. Were interviewed on how they process new information (verbal and non verbal). Four persons were congenitally blind and four had acquired visual impairment later in life. Five were totally blind and three were low vision.

**Procedure**
Using an open ended questionnaire the blind persons were interviewed about how they make sense of the world around them. How do they constantly use information that they gather through the senses and information that they have already stored in memory.
Results and Discussion
The qualitative analysis of the data revealed that:
At the Input phase the information when presented in auditory form is best processed. When information presented is visual or abstract in nature it becomes hard to comprehend for the blind persons. Help is sought from peers to verbalize the visual information for them. Tactual exploration is combined with auditory inputs but generally not simultaneously. During the phase of Processing a lot of rehearsal is done to form the concept. If the new information can be linked to the previous knowledge, concept formation is easier but forming new schemata is difficult. Self learning is faster than the mediated learning. When it is mediated through a peer, it also depends on the skill of the peer to transfer the information. Mostly persons with visual impairment have to depend on their peers and rely on the explanations given by them. The possible mismatch between the speed at which the explanation is given by the peer and the speed at which the information is processed by the visually impaired could lead to disorganized storage of information in their cognitive structure. Inadequate storage could result in faulty and incomplete retrieval of information. This eventually either leads to over sharpening of some details and leveling of some other. Despite their efforts the visually impaired are disadvantaged due to dependency on others for information input.

When the tasks are with visual orientation, comprehending the same is difficult for the blind particularly for the congenitally totally blind persons. Integration of auditory, tactile and kinesthetic senses takes longer. Repeated experience is important and necessary. All input stimuli that activate a sensory receptor cell are processed differently (simultaneously or successively) at different levels of processing (shallow and deep) for storage in the long term memory. The type of processing contributes to the ability to access, or retrieve that information. When the demands for accessing information match the methods used to elaborate or learn the information, more is remembered. Tasks which are sequential in nature are remembered better because often the visually impaired process the information successively and their sequential learning has been reported to be strong.

Conclusions
Some factors affecting information processing and representation of knowledge among the visually impaired were identified as follows:

- The eye condition (low vision or totally blind), and the age of onset affect information processing. Those with congenital total blindness find abstract information more difficult to comprehend. Part learning is easier than holistic learning.
- Socio-economic background affects the variety of experiences the visually impaired person has had. More stimulating the environment they have been exposed to, the easier it becomes for them to form concepts through associations with past experiences.
- There are individual differences among the visually impaired also as they are observed in the sighted.
• Those with good memory skills are better equipped to organize and retrieve information.

• Students who are very efficient in Braille take down notes in Braille which they refer to for later revision. Others depend more on peers and rely on explanations given by them. Such person mediated learning is, sometimes, not as efficient as self learning.

• The visually impaired persons who have studied in integrated set up are more confident, and do not feel that they are lagging behind their sighted peers in any way.

• The blind possess extremely good listening skills as they are provided training from the very beginning.

• They perform better in tasks requiring sequential memory.

• They pay good attention and concentrate well to the auditory input.

• Their brain areas adapt to loss of vision by becoming more involved in processing language-related tasks.

• Use of technology also aids in learning but acquiring efficiency in the same takes time. There may be initial lag in comparison to the sighted peers but once they get proficient in the use of technology they do not lag behind.

References


