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"Current Comments"

Using the *SCI* to Illuminate Scotophobin

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Is memory contained in a chemical substance which can be transferred from one individual to another? It is a question whose answer may have enormous implications for education, for all fields of science, and for our entire society. Therefore, it seemed a worthwhile question with which to demonstrate how easy it is to use the *Science Citation Index*® (*SCI*®).

An hour's instruction is more than enough to make a competent *SCI* user out of an amateur--someone who's neither skilled in the use of indexes nor an expert in the subject area under investigation. Of course, for someone who *is* a subject specialist or an index sophisticate, using the *SCI* is even easier.

In order to illustrate the *SCI's* effectiveness in the hands of someone with no prior knowledge of chemical memory transfer, I asked A. E. Cawkell, ISI® 's Director of Research and Development to undertake an *SCI* search. His goal was to compile a bibliography on the subject.

Cawkell began his search with just two references, which were given to him by a specialist in the field. This was all he needed. The *SCI* provided the rest.

Before discussing the results of Mr. Cawkell's search, it may be interesting to recall briefly the beginnings of the study of chemical transfer of memory.

In 1962, a fascinating and seminal paper was published by James V. McConnell of the University of Michigan.[1] In it, he describes his pioneering studies with planaria in 1953, when he began wondering what would happen if he "conditioned a flatworm, that cut it in two and let both halves regenerate. Which half would retain the memory?" He found that "the tails not only showed as much retention as did the heads, but in many cases did much better than the heads and showed absolutely no forgetting whatsoever. Obviously memory, in the flatworm, was being stored throughout the animal's body...."

In 1957, two groups of "worm runners"[1] hypothesized that memory could be transferred from a trained animal to an untrained one. They tried grafting the heads of trained flatworms onto the tails of untrained planaria. They tried grinding up the trained worms and injecting the pieces into the untrained worms. Finally, they decided to take advantage of the fact that under certain conditions, one flatworm will eat another. They conditioned a group of worms, chopped them into small pieces, and hand-fed the pieces to untrained "cannibal" worms.

They found that the cannibals which had eaten trained worms gave 50% more conditioned responses than a control group of cannibals which had eaten untrained worms. This demonstrated that a chemical substance being stored throughout the worms' bodies--probably RNA--was responsible for memory transfer.

In 1968, Ungar, Galvan and Clark,[2] working with rats, again demonstrated memory transfer. This time, however, the animals were trained to avoid the dark. When material extracted from the brains of trained rats was injected into untrained rats, the untrained animals also displayed fear of the dark.

The material responsible for this transfer of memory was dubbed *scotophobin*, from Greek *skotos* (darkness) and *phobos* (fear). It has since been found to lessen the time spent in the dark by rats, mice, goldfish, and roaches.[3]

Cawkell's *SCI* search produced an extensive bibliography and citation network for scotophobin--without the need to understand and assimilate the subject matter in each paper. The bibliography is reproduced on the following pages. Readers interested in the citation network diagrams can write to me.

It is enlightening to compare the performance of the *SCI* in this search with the expected performance of traditional indexes to the scientific literature. If Cawkell had used the largest biomedical index available he would *not* have found a heading for *SCOTOPHOBIN*--not in this year's index; not in any previous year. Not even a cross-reference.

In another traditional index one item from the bibliography was found in a rather unexpected place. The item was listed under *DARKNESS*--an ironically appropriate heading.

Are there other chemical substances like scotophobin which contain the essence of memory and knowledge? Will some of these phobins, when ingested by humans, induce specific fears other than fear of the dark--such as fear of certain objects, symbols, words, or individuals? If *phobins* induce fear, are there also *philins* (to coin a term) which induce *preference*?

As always, scientific progress can lead to good or to evil. Along with the prospect of memory pills comes the prospect of a fiendishly effective love potion. We can only hope that probins are never used as weapons by the military, and that philins never fall into the hands of advertising agencies.

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SELECTED BIBLIOGRAPHY ON SCOTOPHOBIN AND 'MEMORY TRANSFER'

The items are arranged by year of publication, and within year by first author. This bibliography is 'selected' because it does not include all of the almost 200 articles identified in Mr. Cawkell's search. In Mr. Cawkell's words: "The references provided by Ungar and Stewart [items 50 and 48 in this list] were used as entry points into the *Citation Index*, and articles citing them were noted. A few of the more heavily cited articles were obtained, and the same process was repeated ("cycling") using their references as entry points. [In this cycling] a cut-off decision has to be made at some point beyond which it is considered that further searching would be unrewarding. The searcher has to make decisions about the branches to pursue, based on information acquired as the search proceeds, if he knows nothing at the outset... The searcher has to arbitrarily decide just what constitutes "the subject". In fringe areas, what should be listed and what should be omitted? For the non-subject expert these three limitations may be eased by reading a small number of key articles. (Putative key articles, which usually turn out to be *de facto* key articles, are the most heavily cited. These most cited articles are of course identified from the *SCI*.) From a perusal of portions of text keyed to specific references, a selection from the total number of retrieved articles was made..."

The bibliography which follows is that "selection." The effectiveness of this almost wholly algorithmic search technique can be evaluated by the reader. By chance, a review article, item 75 on this list, was being prepared at about the same time Mr. Cawkell made his search. In a last-minute updating of Mr. Cawkell's search in preparation of this editorial, that review article was retrieved. Readers may be interested in comparing this bibliography with that of the review by Mitchell *et al.*

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