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BRAINSCAPE! A Pascal adventure in neuroanatomy for IBM-PCs and compatibles

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Even before the advent of the personal computer, textual adventure games were popular. The first of these, which gave its name to the entire genre, was *Adventure*, written by Woods and Crowther and implemented on a mainframe computer. In it, the player explored a complex environment that existed wholly in the memory of the computer. Two-word commands instructed the player's computerized counterpart to move ("Go west"), explore ("Examine room"), and deal with restless natives ("Hit troll"). Successful exploration yielded both immeasurable wealth, in the form of discovered treasures, and a safe exit from the large cavern in which the adventure was set.

This mainframe adventure soon found itself shoehorned into the smaller memory of the personal computer, and rapidly gave rise to numerous programs in the same mold. Although the settings and plots of these programs differ, they share several features. The computer serves as a window onto another world, a world that the player can explore in any way that he or she sees fit. Exploration, problem solving, and the avoidance of hazards are common to all of them.

We recognized the adventure game as an excellent approach to the teaching of neuroanatomy. Brainscape is a textual adventure that is set in the brain. The player explores the brain, gaining points by entering new regions, finding neurotransmitters and cells, and solving problems. This interactive technique of gaining familiarity with brain structures holds the attention of students and encourages them to examine their textbooks for "maps" of the world that they are exploring.

The Player. Brainscape is best suited for students encountering neuroanatomy for the first time, although it will also refresh the memory of more advanced students. Compared with other adventure games, Brainscape is relatively simple to "solve." We decided that it was more important to allow the student to explore freely than to impede exploration with difficult problems. Thus, almost all areas of the brain can be entered before solving any problems. However, enough logical problems exist to hold the interest of even an experienced adventurer, and to compel further use of the program. High scores are impossible without mastering some of the problems.

The authors wish to thank C. L. Wilson, K. S. Bordens, and our students for their assistance in the development of this program. Address all correspondence to W. Jeffrey Wilson, Department of Psychological Sciences, Indiana University—Purdue University at Fort Wayne, 2101 Coliseum Blvd. East, Fort Wayne, IN 46805.

We have used Brainscape in undergraduate courses in physiological psychology with great success. Neuroanatomical terms take on greater relevance to the students through the use of the program, and scores on neuroanatomy examinations have improved.

The Environment. The player enters the brain from the blood supply, through the choroid plexus of the lateral ventricle. From here, the player can explore approximately 50 sites within the brain, including other parts of the ventricular system, the cerebral cortex, the basal ganglia, the limbic system, the diencephalon, and numerous midbrain and brainstem regions. Carlson (1986), Carpenter (1985), and Diamond, Scheibel, and Elson (1985) served as sources of the information in the program. We have taken some liberties in our representation of the anatomy of the brain, mostly by omitting areas that, though important, may not be crucial to an undergraduate's understanding of the brain.

Movement is commanded via standard anatomical terms: the player's computerized counterpart is instructed to "Go medially" or to "Run rostrally," for example. Only the six standard anatomical directions are employed: rostral, caudal, dorsal, ventral, lateral, and medial. Thus, we have somewhat simplified the anatomy of the brain by eliminating directions such as dorsomedial or rostroventral.

Goals. The student will gain the highest score by exploring as much of the brain as is possible, finding treasures, and solving problems.

The treasures consist of five different neurotransmitters, found in appropriate parts of the brain. In order to pick up each neurotransmitter, the student must first find the appropriate vesicle. There are also two neurons and a glial cell that can be taken, all adding to the score.

Several problems exist. Vesicles must be found before the transmitters can be taken. The player can carry only a limited number of items. Outside the brain, the immune system will attack an unprotected player. Growth hormone must be found if the player is to return to normal size upon leaving the brain. Two inhabitants of the brain, one a threat (Golgi's Ghost) and one apparently harmless (The Homunculus) enliven the exploration of the brain. All problems have logical solutions, and solving each problem adds to the total score.

It is possible to become lost in one area of the brain. If this occurs, random wandering will rescue the player.

At several points in the brain, a question must be answered in order to progress. A correct answer causes the player to be sent to an unexplored area of the brain. Two incorrect answers in a row result in a rapid end to the game. The questions are related to the region the subject is currently visiting and are selected from a pool of approximately 45 questions.

The Program. Brainscape is written in Turbo Pascal (Borland International, 1983) for the IBM-PC, PCjr, and

compatibles. The program is compiled and does not require Turbo Pascal to run. It will run on monochrome or color systems with at least 128K of RAM and one disk drive.

Each location within the brain is encoded by a record that contains the location's name, the sites that can be reached by movement in each direction, the objects that are present at that location, and a Boolean variable that indicates whether or not the location has previously been visited. When a movement command is issued, the program simply consults the current location's record of adjacent sites to determine what record should become the current one.

Brainscape's parser is relatively simple. The first three letters of the first word in a two-word command are compared with several lists of possible commands. If a match is found, the program compares the first three letters of the second word to a list of objects on which that command can be enacted. If a match is found, the program carries out the command; if not, the player is informed that the command makes no sense. Each list contains various synonyms, so the program can usually recognize appropriate commands despite some variation in word choice. The program's response to a command is immediate, in part because compiled Pascal is a fast language.

Availability. To receive the compiled version of Brainscape, the source code, documentation that can be dumped to a printer, and a brief "ReadMe.txt" file that tells how to perform this dump, send a 5¼-in. double-sided, double-density diskette and a reusable diskette mailer to W. J. Wilson.

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