DOCUMENT RESUME

ED 031 962 EM 007 421

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Project TAPS. Teaching Anatomy with Programmed Schematics. Progress Report Number 1.

Harvard Univ., Cambridge, Mass. Computation Lab.
Spons Agency-Public Health Service (DHEW), Washington, D.C.
Pub Date Jul 69
Note-22p.
EDRS Price MF-$0.25 HC-$1.20
Descriptors-Abstracts, Achievement Tests, *Anatomy, Attitude Tests, Computer Assisted Instruction, Computer Oriented Programs, *Computer Programs, Experimental Programs, *Instructional Materials, *Instructional Programs, Programed Instruction, Programed Materials, *Programed Tutoring, Schematic Studies

Experimental Programed Instruction of the anatomy of the maxillary division of the trigeminal nerve is being conducted by the Harvard Computer-Aided Instruction Laboratory in cooperation with Tufts University Dental School. Two nearly identical programs are presented, one (PF) using representational diagrams and the other (PD) a schematic diagram and identification key. First year dental students were randomly selected and divided into four groups, each group taking the four sections of the two part course in a different sequence. Attitude testing toward programed instruction and subject achievement testing was performed both before and after the course. The entire course requires an average two and one-half hours of student time. Of the six pretest students who took the first three-quarters of the course, it was found that Program PD yielded the most gain on Sections One, Two, and the total, but Program PF yielded more on Section Three. There was less overall gain on Section Three than on the other two sections. More data will be accumulated in the academic year 1969-70. Included in the document are examples of the schematic and representational diagrams, pre- and post-attitude questionnaires, achievement tests, sample lessons, a table of results, a program abstract and a list indicating distribution of the document. (SH)

Progress Report No. 1

U.S. Public Health Service Contract No. PH 108-69-18

Project TAPS
(Teaching Anatomy With Programmed Schematics)

HARVARD UNIVERSITY

COMPUTING CENTER

GRADUATE SCHOOL OF EDUCATION

Computer-Aided Instruction Laboratory
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Progress Report No. 1

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Project TAPS
(Teaching Anatomy With Programmed Schematics)

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July, 1969

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Abstract

This report details the status of Project TAPS (Teaching Anatomy with Programmed Schematics), a project supported by the U. S. Public Health Service and being conducted by the Harvard Computer-Aided Instruction Laboratory in cooperation with Tufts University Dental School. More specifically, it describes TRIGEM, the CAI course developed as a part of Project TAPS to teach the anatomy of the maxillary division of the trigeminal nerve. This course is currently operational on the Harvard CAI System which uses an IBM S 360/Model 65 as the central processor, teletypes and IBM 1050 terminals as the student interface, and CAILAN as the interactive language which operates under OS. An abstract of TRIGEM is included at the end of this report.

The CAI course TRIGEM is based on programmed instruction materials which have been adapted for presentation by the IBM S 360/65 instructional system at Harvard University. The course can be accessed by either a standard teletype or an IBM 1053 terminal connected to a 103A2 dataset. With the cooperation of Dr. William M. Feagans at Tufts, five teletypes were installed in a trailer adjacent to the school area and connected by telephone lines to the Harvard system.

TRIGEM consists of two almost identical programs, PF and PD, which differ only in the graphic representations used. Program PF uses two representational diagrams (Fig. 1) taken from Gray's Anatomy. Program PD uses a schematic diagram and identification key (Figs. 2 and 3). These materials were dry-mounted on heavy cardboard and made available to students at the terminal. Each program requires approximately 1 and 1/4 hours of student time, depending on response rate.

Pilot Study*

Design. For the purpose of this study, the design which was planned made use of four groups of students, drawn at random from the first-year class at Tufts Dental School. Each group was to take the two parts of the course in a different sequence: Group A, PD twice in succession; Group B, PD first and then PF; Group C, PF first and then PD; and Group D, PF twice in succession.

All students were to be asked to fill out an attitude questionnaire and take a written test on content, both before and after the course. The

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*Spring-semester students were used.

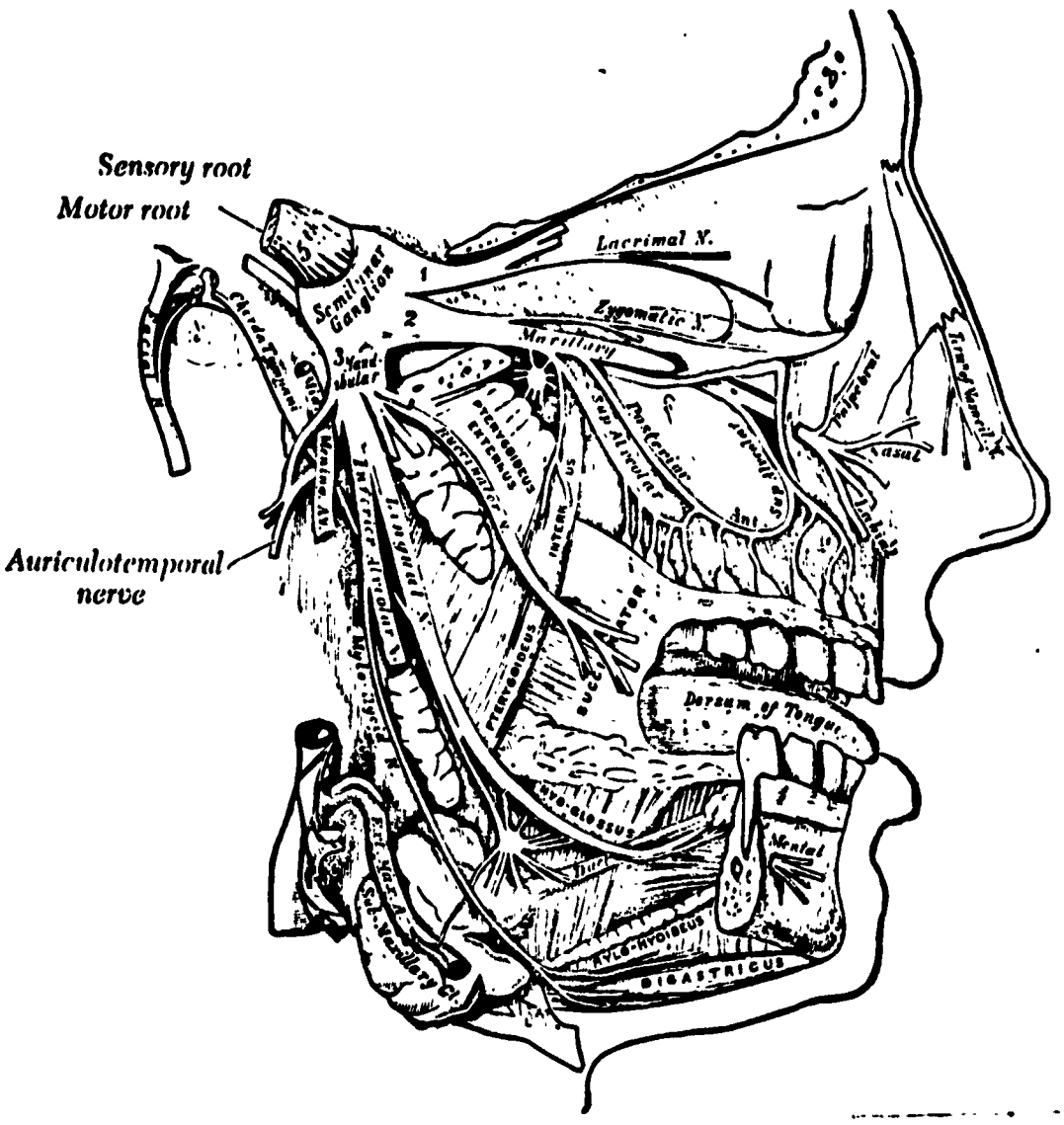


Fig. 1. The two representational diagrams used in Program PD of the CAI course TRIGEM.

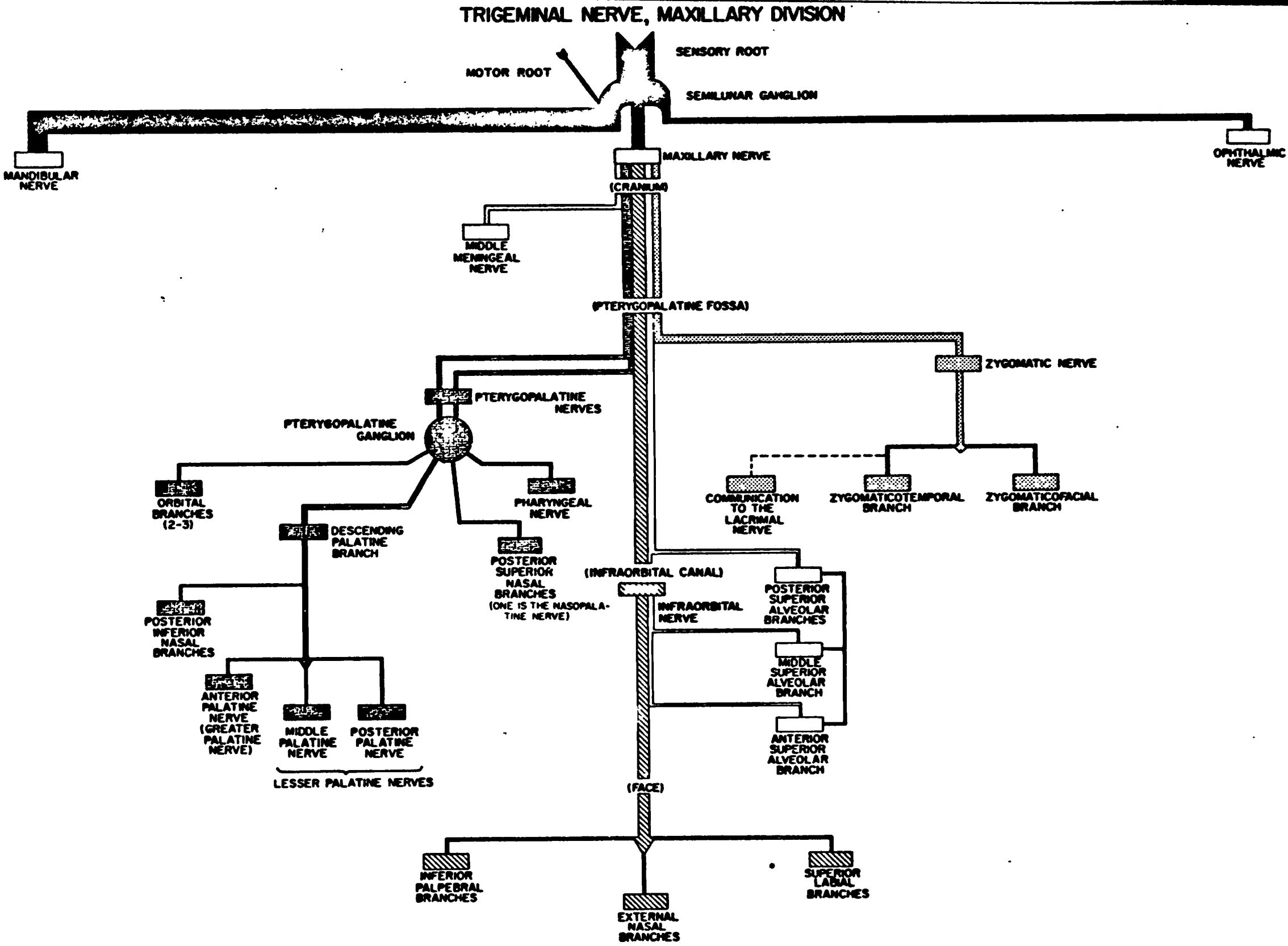
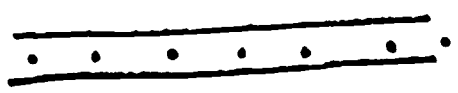
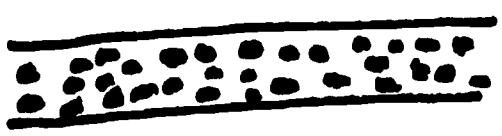


Fig. 2. The schematic diagram used in Program PF of the CAI course TRIGEM.

Symbol	What the symbol represents
	nerve root
 maxillary nerve	nerve name
rounded forms 	ganglion
	middle meningeal nerve
	pterygopalatine nerve
	facial branches
	superior alveolar branches
	zygomatic nerve

Breaks in the center line contain the names of the regions through which the maxillary passes.

Fig. 3. The identification key used with the schematic diagram shown in Fig. 2.

attitude questionnaire was designed to determine a student's attitude toward CAI before and after his participation in this study. The questionnaire consists of [illegible] statements, to which the student responds "yes", "no", or "maybe", to indicate his degree of agreement. The questionnaire requires about 1 minute to complete. The pre- and posttest forms are identical except for the verb form used (see Figs. 4 and 5).

Before they start the course, students are also given a test question booklet and an answer booklet to determine their knowledge of the subject matter presented. Fig. 6 shows the first page of the test question booklet and Fig. 7, the corresponding page of the answer booklet. The test booklet contains the questions only, and all answers are written in the separate answer booklet. This test yields a fairly thorough measure of the student's knowledge of the structure, function, and terminology of the trigeminal nerve; there is no difference in pre- and posttest forms. Since the only difference between the PD and PF programs lies in the learning aids they use, it is assumed that any significant difference in group average posttest scores on this test is due to a difference in effectiveness of those aids.

Materials. The PD and PF programs are each divided into four sections. The first section of each program provides a description of nerves in general and introduces the student to the trigeminal nerve, of which the maxillary division, the subject matter of TRIGEM, is a part.

The second section of each program teaches the branch configurations of the maxillary division. The student first sketches the configurations of

Scale of Attitudes Toward Computers

Name _____ Date _____

School or Center _____

1. I would learn more quickly by using the computer.	Yes___Maybe___No___
2. I could work at my own speed on the computer.	Yes___Maybe___No___
3. It would be interesting to work by computer.	Yes___Maybe___No___
4. It would be easier to learn by computer than with a teacher.	Yes___Maybe___No___
5. I would like sitting and working alone.	Yes___Maybe___No___
6. I think students learn better by computer than with a teacher.	Yes___Maybe___No___
7. It would be easier to learn by computer than with films and slides.	Yes___Maybe___No___
8. I think students learn better by computer than with a book.	Yes___Maybe___No___
9. I have used a typewriter.	Yes___A bit___No___
10. I'm afraid I could not learn how to use a computer very well.	Yes___Maybe___No___
11. I would need a teacher as I work on the computer.	Yes___Maybe___No___
12. I would like to use a computer.	Yes___Maybe___No___
13. Using a computer would be like having a friendly teacher.	Yes___Maybe___No___
14. Learning by computer would go too fast.	Yes___Maybe___No___
15. I would not mind if I missed a question while working on a computer since no one would be watching me.	Yes___Maybe___No___

HCAI/Pre-/4/69

Fig. 4. CAI Attitude Scale, pretest.

Scale of Attitudes Toward Computers

Name _____ Date _____

School or Center _____

1.	I learned more quickly by using the computer.	Yes___Maybe___No___
2.	I worked at my own speed on the computer.	Yes___Maybe___No___
3.	It was interesting to work by computer.	Yes___Maybe___No___
4.	It was easier to learn by computer than in a class.	Yes___Maybe___No___
5.	I liked sitting and working alone.	Yes___Maybe___No___
6.	I think students learn better by computer than with a teacher.	Yes___Maybe___No___
7.	It was easier to learn by computer than with films and slides.	Yes___Maybe___No___
8.	I think students learn better by computer than with a book.	Yes___Maybe___No___
9.	I have used a typewriter.	Yes___A bit___No___
10.	I'm afraid I did not learn how to use a computer very well.	Yes___Maybe___No___
11.	I need a teacher as I work on the computer.	Yes___Maybe___No___
12.	I liked using a computer.	Yes___Maybe___No___
13.	Using a computer is like having a friendly teacher.	Yes___Maybe___No___
14.	Learning by computer went too fast.	Yes___Maybe___No___
15.	I did not care if I missed a question while working by computer since no one was watching me.	Yes___Maybe___No___

HCAI/Post-/4/69

Fig. 5. CAI Attitude Scale, posttest.

TEST - Part 1

Fill in the answers to the following questions in the appropriate space on the ANSWER SHEET!!

DO NOT WRITE IN THIS BOOKLET!

1. Write the names of the divisions of the trigeminal nerve. Put the name of the largest division on the first line, the second largest division on the second line, and the smallest division on the third line.

2. Write the names of all the branches and branches of branches of the maxillary nerve in the order they separate. Include the name which the maxillary nerve attains after entering the orbit. In other words, write the name of the first branch in the cranium. Below the name of the first branch write the names of all its branches in order. Then do the same for all other branches of the maxillary nerve in order. You may need more or less space than is provided for question 2 on the answer sheet.

3. In the column titled "3. Area Supplied" on the answer sheet list the general area supplied by each nerve or branch you named for question 2. List the area supplied in the same row in which the nerve is named.

Fig. 6. Page 1 of the test question booklet. Pre- and posttest forms are identical.

ANSWER SHEET

Part 1

Name _____ I D _____

1. _____

_____

_____

2. Nerve Names

_____

_____

_____

_____

3. Area Supplied

_____

_____

_____

_____

_____

_____

_____

_____

Fig. 7. Page 1 of answer booklet. Pre- and posttest forms are identical.

the several component structures of the nerve and then combines them to achieve knowledge of the entire structure.

The third section teaches the names of the nerves and the areas supplied by them. In order to aid the student's understanding and recall of this material, an analysis of each term's Latin components is given, together with the English meanings of these components.

The fourth and last section of each program teaches the regions through which each of the branches of the maxillary division passes. As in the third section, terms are broken down into their Latin components.

Both programs are of equal length, 111 frames. There are two basic frame types, denoted by the abbreviations RD ("Read") and QU ("Question").* An RD frame requires the student to simply read a paragraph (Fig. 8). When he is ready to continue he presses the EOB (End of Block) key, which signals the system to proceed with the course. Some RD frames require the student to draw a sketch of some region of the trigeminal nerve (Fig. 9). A booklet is provided for this purpose. It contains blank pages for the drawings, alternating with pages on which the correct configurations are printed. The student draws his sketch on the designated page of the booklet and then turns the page to find the correct answer (Figs. 10 and 11). When he is satisfied that he knows the configuration, he keys EOB and the computer proceeds to the next frame.

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*These refer to the "op codes" in CAILAN, the CAI language used on the Harvard CAI System.

COMPUTER: NERVES ARE LONG WHITISH STRINGS OF CELL BODIES AND THEIR "APPENDAGES" WHICH CONDUCT MESSAGES FROM ONE PART OF THE ANATOMY TO ANOTHER. THE NERVE APPENDAGES ARE THE LONG PART WE USUALLY REFER TO WHEN WE SPEAK OF A NERVE.
STUDENT (when ready to proceed to next frame): (eob)

Fig. 8. A typical RD frame from the CAI course TRIGEM.

COMPUTER: NOW, WITHOUT LOOKING AT THE DIAGRAM, SKETCH THE DIAGRAMMATIC CONFIGURATION FOR ALL THE PTERYGO-PALATINE NERVES. DRAW ON PAGE 11 OF THE BOOKLET, AND THEN COMPARE YOUR DRAWING TO THE ONE SHOWN ON PAGE 12 OF THE BOOKLET.
STUDENT (after drawing the configuration and checking it): (eob)

Fig. 9. A typical RD frame from the CAI course TRIGEM requiring the student to draw a sketch.

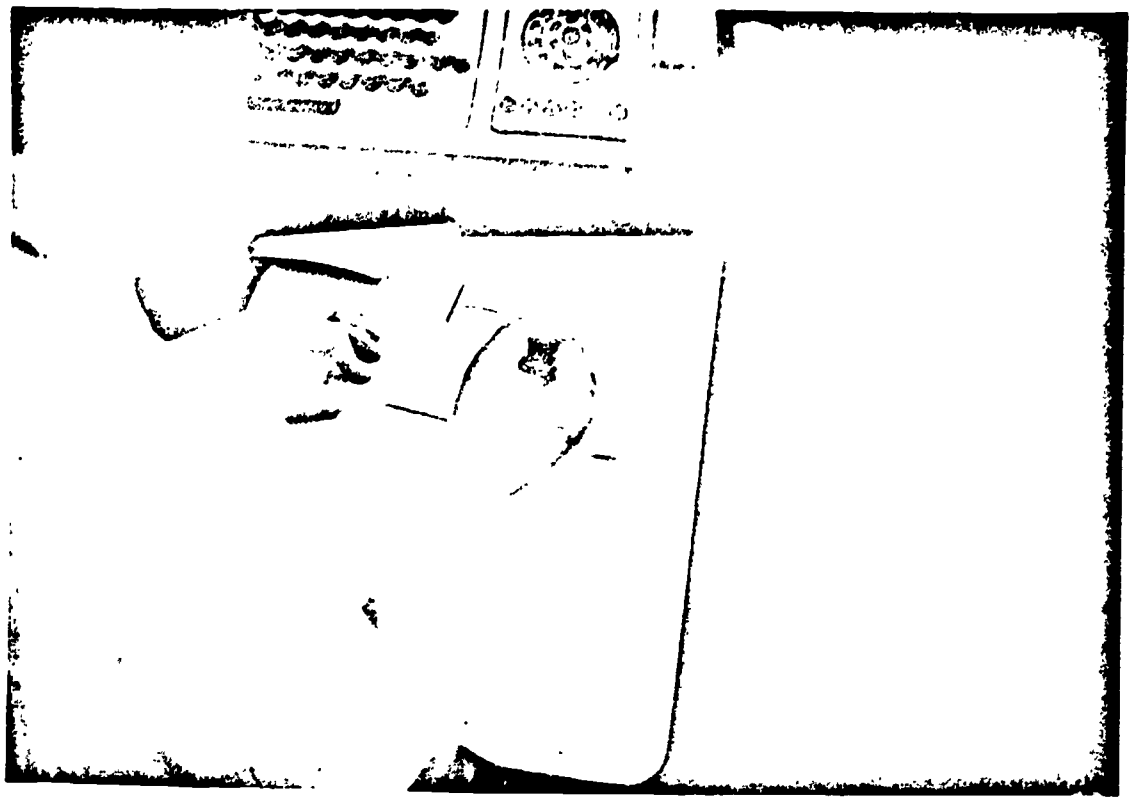

Fig. 10. Student drawing a sketch in the CAI course TRIGEM, at the direction of the computer.

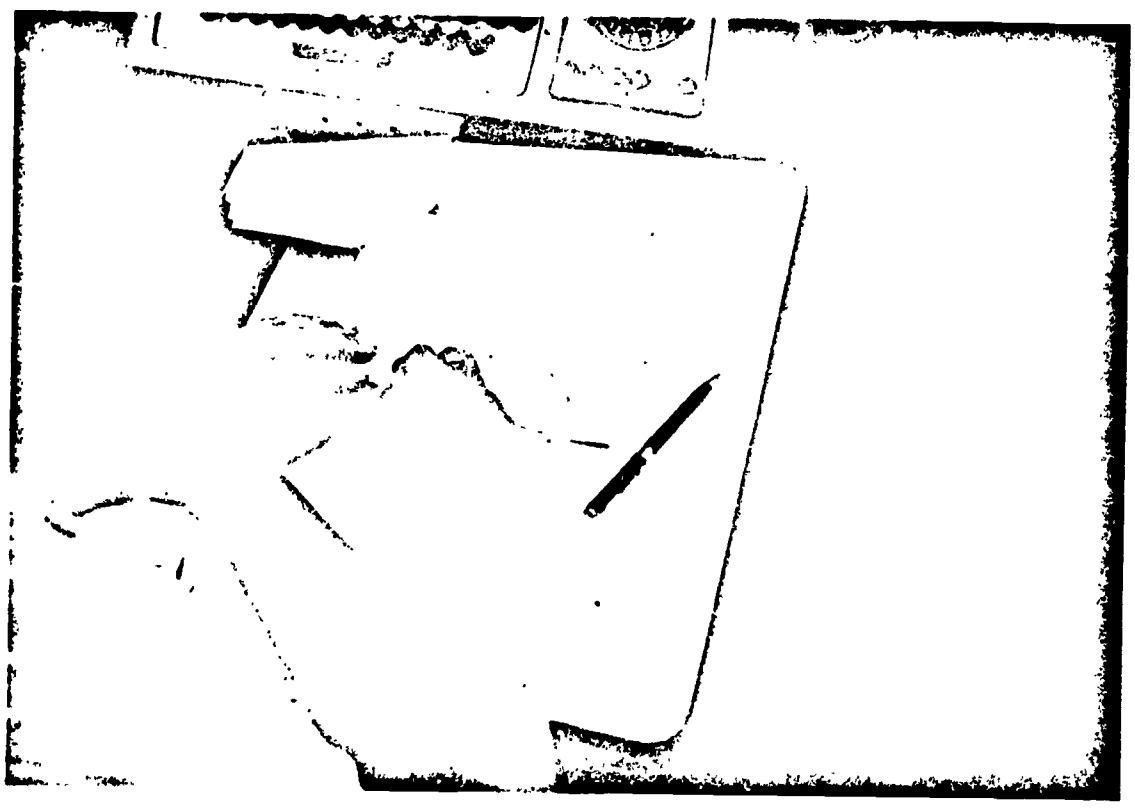

Fig. 11. Student checking the accuracy of the sketch drawn in Fig. 10.

The second basic frame type is the QU frame, which requires the student to type a response. This response may be to fill in a blank or answer a direct question. If the answer is correct, the computer responds by typing CORRECT and proceeding to the next frame (Fig. 12). If the answer is correct but misspelled, the computer responds as shown in Figure 13. This response has been designed to preserve morale by calling the student's attention to his misspelling indirectly, i.e., without actually telling him that he has made an error. Figure 14 shows one of the computer's responses when the student's answer is incorrect. If the student's answer is incorrect, the computer tells him he is incorrect, gives him the correct answer, and proceeds to the next frame. This is called non-correction procedure.

Results. To date, six students (3-PD, 3-PF) have taken the course. No student took the whole course because it took too long for the time available -- about two and one-half hours. In addition, they also completed the pre- and posttest forms of the CAI attitude questionnaire and achievement test. These data are being examined for information that will be employed in revising the program for use with a larger number of students in the fall of the 1969-1970 academic year.

Table 1 summarizes the results obtained from the pre and post forms of the achievement test. If we compare the differences between pre- and posttest scores for both groups we find that the group who studied with the schematic diagram showed the larger gains on Parts 1,

COMPUTER: LOOK AT THE DIAGRAM. THE PTERYGOPALATINE NERVES APPEAR TO FORM THE ..... GANGLION. ACTUALLY THEY PASS RIGHT THROUGH THE GANGLION AND DO NOT FORM IT.
STUDENT: PTERYGOPALATINE (eob)
C: CORRECT

Fig. 12. A typical QU frame correctly answered by the student.

COMPUTER: ONE BRANCH OF THE POSTERIOR SUPERIOR NASAL BRANCHES IS LONGER THAN THE REST. THIS BRANCH IS NAMED ON THE DIAGRAM AND IS THE ..... .
STUDENT: NASOPALITINE (eob)
COMPUTER: RIGHT--THE NASOPALATINE NERVE.

Fig. 13. A typical QU frame to which student gives a correct but misspelled answer.

COMPUTER: ONE BRANCH OF THE POSTERIOR SUPERIOR NASAL BRANCHES IS LONGER THAN THE REST. THIS BRANCH IS NAMED ON THE DIAGRAM AND IS THE ..... .
STUDENT: PHARYNGEAL (eob)
COMPUTER: INCORRECT. THE CORRECT ANSWER IS NASOPALATINE.

Fig. 14. A typical QU frame incorrectly answered by the student.

TABLE 1

Scores* made by Six Dental Students on Pre and Post Forms of Achievement Test used in TRIGEM Pilot Study

Form of Program	S No.	Pretest Part No. 1	2	3	Total	Posttest Part No. 1	2	3	Total	Configuration**	Differences Part No. 1	2	3
PD	1	8	9	8	25	39	28	6	73	23	31	19	-2
	3	7	10	5	22	39	26	10	75	23	32	16	5
	6	6	8	1	15	32	23	8	63	15	26	15	7
PF	2	22	6	5	33	29	16	7	52	18	7	10	2
	4	5	7	8	20	33	25	10	68	22	28	18	2
	5	4	4	4	12	37	23	15	75	24	33	19	11

Key

* A student's score is directly related to number of correct responses.

** In the post form of the achievement test, the student is asked to reproduce the schematic he used during the program. His score depends on the accuracy and detail of his representation, with reference to certain predetermined performance measures.

2, and the total, but the group that studied with the representational diagram achieved bigger gains on Part 3. In general, gains on Part 3 were substantially lower than for the other two parts.

Plans

A request was made and honored to extend the terminal date of the project so that more students can be run to complete the experimental design which is a 2 x 2 analysis of variance, as previously described. Mr. Samuel H. Desch is working as a Research Assistant at the Harvard CAI Laboratory and will run the study and analyze the data. If data from the experience in the fall corroborate those obtained in the spring, either a request for an extension of the project will be made or a proposal will be submitted for a new but related project.

A set of slides and a description of the study was sent to Dr. Luigi Luccaccini, HEW Dental Health Center, San Francisco, to be used in a presentation at a World Health Organization meeting in South America.

HARVARD CAI LABORATORY: PROGRAM ABSTRACT

Program Name: TRIGEM

Subject Matter: the maxillary division of the trigeminal nerve

Author(s): Based on Johnson, R. P. The effect of mnemonic learning aids upon immediate recall of neuroanatomical facts. Master's Thesis, University of Illinois, 1966. Adapted for CAI presentation by S. H. Desch (Harvard CAI Laboratory).

Programmer(s): S. H. Desch

Target Population: first year dental (primarily) and medical students

Length of Program: approximately 1-1/4 hrs. of student time required

Instructional Logic: tutorial

Instructional Language: CAILAN

Computer: IBM S 360/65, Harvard Computing Center

I/O Devices: IBM 1050 terminal or standard teletype

Auxiliary Equipment: representational diagrams or schematic diagrams are given to students before they start the program

Installation(s): remote terminals at Tufts University Dental School, Medford, Mass. and at the Harvard CAI Laboratory, Cambridge, Mass.

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