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ABSTRACT

The major purpose of the present experiment was to assess the impact of student-generated and expert-generated knowledge maps on the effectiveness of post-organizer construction, initial acquisition, and transfer. Sixty students at the University of Missouri-Rolla were included in this study. Participants were required to study a passage and create a summary of the material in one of three conditions. Those in the text-map group (TM) and those in the text-text group (TT) studied a passage in the form of traditional text, while those in the map-text group (MT) studied the passage in the form of a knowledge map. Those in groups TT and MT created a summary in the form of traditional text, while those in group TM created a summary in the form of a knowledge map. Following the summary, all groups studied a second knowledge map that described psychological research designs. Students completed recall tests over both passages 2 days later. Results indicate that students in all groups performed better on the summary (post-organizer) than on either recall test, and recalled significantly more information from the text passage than from the experimental design passage. TT subjects performed better than did the other groups on post-organizer accuracy, while the other two groups recalled more of the information in the transfer passage. Post-organizer accuracy proved to be a significant predictor of recall in MT subjects, while post-organizer accuracy and recall were largely unrelated for the other groups. A 28-item list of references, two data tables, and a figure providing part of a knowledge map are included. (Author/TJH)

Student- Versus Expert-Generated Knowledge Maps: Postorganization, Initial Acquisition, and Transfer

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Abstract

The major purpose of the present experiment was to assess the impact of student-generated and expert-generated knowledge maps on the effectiveness of post-organizer construction, initial acquisition, and transfer. In addition, the relationship between organizer accuracy and recall was examined as mediated by experimental condition. Participants were required to study a passage over the autonomic nervous system and to create a summary of the material in one of three conditions. Those in the text-map group (TM) and those in the text-text group (TT) studied a passage in the form of traditional text, while those in the map-text group (MT) studied the passage in the form of a knowledge map. Those in groups TT and MT created a summary in the form of traditional text, while those in group TM created a summary in the form of a knowledge map. Following the summary, all group studied a second knowledge map that described psychological research designs. Students completed recall tests over both passages two days later. Results indicated that students in all groups performed better on the summary (post organizer) than on either recall test, and recalled significantly more information from the ANS passage than from the experimental design passage. A marginally significant group X passage interaction indicated that group TT performed substantially better than the other groups on post-organizer accuracy, while the other two groups recalled more of the information in the transfer (research design) passage. In addition, post organizer accuracy proved to be a significant predictor of recall for those in group MT, while post organizer accuracy and recall were largely unrelated for those in the other two groups.

Student- Versus Expert-Generated Knowledge Maps:

Postorganization, Initial Acquisition, and Transfer

Spatial representations of text have become much more popular in recent years (Bean, Sorter, Singer, & Frazee, 1986; Davidson, 1982; Diekhoff, 1982; Gold, 1984; Kraft, Novie, & Kulhavy, 1985). Such textual displays have become more cost effective due to the plethora of recent technological innovations (e.g. laser printers, interactive drawing and word processing software). There is also a growing amount of evidence that such displays can serve as effective adjuncts to (e.g., Alvermann, 1981; Moore & Readence, 1984; Sinatra, Stahl-Gemake, & Berg, 1984;) and even substitutes for (Darch, Carnine, & Kameenui, 1986; Sinatra, Berg, & Dunn, 1985) traditional textual displays. The purpose of the present experiment was to examine one particular type of spatial-textual display, knowledge maps (Dansereau et al., 1979; Holley & Dansereau, 1984). Knowledge maps present information via a three dimensional node-link network. (Figure 1 is an example of a portion of a knowledge map used in the present experiment.)

Both expert-generated (e.g., Hall, Dansereau, & Skaggs, 1989; Rewey, Dansereau, Skaggs, Hall, & Pitre, in press; Skaggs, Hall, & Dansereau, 1989) and student-generated (Holley & Dansereau, 1984; Holley, Dansereau, McDonald, Garland, & Collins, 1979) knowledge maps have been found to enhance acquisition relative to traditional text. However, the majority of more recent research has focused on expert-generated maps (e.g., Hall et al., 1989; O'Donnell et al., 1988; Rewey et al., in press; Skaggs et al., 1989). Further, student-generated maps have never been explored as adjuncts to traditional text, nor have they been compared to expert-generated maps within the same context. Although

there has been a paucity of research aimed at student-generated knowledge maps, a number of investigations have examined student-generated "graphic organizers" as text adjuncts (e.g., Alvermann, 1981; Bean et al., 1986). These organizers are similar to knowledge maps in that they use the spatial organization of the text to help convey ideas, however these methods often do not include structural elements such as links and nodes, nor are there different types of links as in Holley and Dansereau's (Holley & Dansereau, 1984; Holley et al., 1979) networking system. The research with respect to expert- versus student-generated organizers has been equivocal. While data from experiments that have compared the two indicate that student-generated organizers are more effective (Moore & Readence, 1980) the effectiveness of the student-generated organizers may be due largely to the active processing required for organizer generation (Darch et al., 1986; Denner, 1986). The present authors suggest that the inconsistency of these results can be, at least partially, explained by the consideration of two additional factors, that is, the use of these methods as text substitutes vs adjuncts. and the consideration of the impact of the methods in terms of effect at initial acquisition and transfer.

A number of studies have also found that student-generated graphic organizers can serve as effective post organizers (e.g., Moore and Readence, 1980; 1984). However, the relationship between the accuracy of these organizers and students acquisition of the material has not been examined. That is, is the effectiveness of the organizers due to students active processing of the material, resulting in the sublimation of the material into existing schemas, or is it due to the creation of an organizer that accurately represents the stimulus material studied? In the first case, one could argue that there would be a minimal relationship between the accuracy

with which the organizer represents the initial material and recall, since deviations from the material will represent manipulations that tie the material to existing schemas. Investigators have suggested that the subsuming of information into existing schemas acts to accentuate some types of information (i.e., schema modifying) and obscure others (i.e., schema implied) (Derry, 1984). However, one could argue that the organizer acts as a method for effectively organizing the material for accurate retrieval, thus the accuracy of the organizer would be strongly predictive of recall. The authors suggest that the importance of this organizer/recall congruence may be largely due to the method of acquisition of the material. It may well differ as a function of the spatial versus verbal nature of the post-organizer students create.

In addition to analyses of organizer and recall relationships, there has been little research that has examined spatial text displays as vehicles for the transfer of skills to subsequent study situations. While there is some research that indicates that these methods may result in across-task transfer (Bean et al., 1986; O'Donnell, Dansereau, & Pitre, 1988), pre-exposure to knowledge maps or other types of graphic displays have not been examined in terms of transfer to other graphic displays consisting of different types of material.

The experimental questions cab be stated as follows: 1) What is the effect of a student-generated, expert-generated, and control display experimental condition on; a) post organizer accuracy; b) initial acquisition; and c) transfer to the studying of an expert-generated knowledge map over another subject area? 2) What is the relationship between post organizer accuracy and acquisition; a) across all groups; and b) as a function of experimental group.

Method

Participants

Sixty subjects recruited from general psychology classes at the University of Missouri-Rolla participated in all phases of this experiment. They received class credit for their participation.

Materials

During the training phase of the experiment (see below) students used two 500 word passages (the first a comparison of football and baseball and the second a comparison of Dallas and Fort Worth, Texas), and a knowledge map that represented the material in the football/baseball passage. During the experimental treatment phase, students studied two bodies of material, each consisting of approximately 1,500 words developed by the authors with consultation from subject area experts. These materials are shortened versions of knowledge maps and corresponding text used in previous research (Hall et al., 1989). One passage consisted of a description of the autonomic nervous system, emphasizing comparisons between the sympathetic and parasympathetic nervous systems. The second passage described psychological research designs, placing an emphasis on a comparison of manipulation experiments and assessment/observation studies. The passages were presented to students either as a knowledge map or traditional text. (Figure 1 is an example of a portion of one of the knowledge maps used in this experiment.) The passage on psychological research designs was presented to all students in the form of a knowledge map.

Procedure

The experiment was run in two sessions, with one day separating the two sessions. The first session began with a brief description of the experiment. All students were then allowed a few minutes to look over the football/baseball map and text. Following this, an experimenter went over the map with the students. As a final step in training, students were allowed ten minutes to look over the Dallas/Fort Worth passage and construct their own knowledge map to represent this passage. Participants were then randomly divided into one of three groups: MT (map/text); TM (text/map); or TT (text/text). Students were then asked to study the materials over the autonomic nervous system for twenty minutes. Those in group MT studied the material in the form of a knowledge map, while those in groups TM and TT studied traditional text. Following this, students were given fifteen minutes to create a summary of the material they had studied. (They were permitted to look back at the materials as much as they chose.) Those in group TM were required to produce their summary in the form of a Knowledge Map and those in groups TT and MT were asked to produce their summary in the form of traditional text. All students were then required to study the knowledge map over research designs for thirty minutes.

The second day of the experiment students were required to complete a free recall test over both the autonomic nervous system and research design. On each of these tests students were simply asked to recall all that they could remember over the material they had studied. They were allowed fifteen minutes for each test.

Results

Recall scores for the summary (post organizer) , ANS recall, and design recall were scored by a trained rater using a procedure developed by Meyer (1975) and Holley et al. (1979). Reliability was established by having a second trained rater score fifteen tests drawn at random for all three types of recall The correlations between the two raters were .93, .93 and .96 for the summary, ANS recall, and design recall respectively. Recall will be reported as a proportion, with a score of 1.00 representing verbatim recall of all propositions located in a passage.

The analyses began with a two-way repeated-measure analysis of variance with condition (map/text; text/map; text/text) serving as the between-subject factor and Recall (summary, ANS, and design) as a within-subject factor. A significant main effect for recall was found $F(2,102) = 36.89$, $p < .0001$, while the Group X Recall interaction was marginally significant $F(4,102) = 2.27$, $p = .07$. (The cell statistics associated with this ANOVA can be found in Table 1.) Tukey post hoc tests (Hays, 1981) were computed to compare the means at each level of recall. Participants scored significantly higher on the Summary ($M = .35$) than they did on ANS recall ($M = .22$), which in turn was significantly higher than design recall ($M = .12$).

In order to assess the relationship between the accuracy of the organizer and recall, as well as the mediational role of experimental group, a regression equation was constructed to predict ANS recall. Variables were entered into the equation in a step wise fashion. In order to exclude any extraneous effects of group this variable was entered first followed by participants summary score, and finally an experimental group X summary variable. The results can be seen in Table 2.

While the organizer score accounted for a marginally significant amount of unique variance in ANS score, this effect was clearly mediated by the interaction of Group and Summary scere, as this variable accounted for a significant amount of variance. In order to further elı cidate the nature of this interaction, zero-order correlations were compute between summary and ANS recall for each of the three groups. These correlations for group TM, MT, and TT respectively were: $r = -.11$, $r = .60$, and $r = .24$. Only the correlation within group TM was significant at the $p < .05$ level.

Discussion

The first experimental question posed above involved the effect of experimental group on acquisition. As there was no main effect for group, it appears that, whether student produced knowledge maps, studied from expert-generated maps, or studied traditional text, acquisition of the material and the accuracy of post organizer production did not differ. There was, however, some suggestion that the situation may be more complicated when one considers the type of recall as a mediational variable (as indicated by the marginally significant interaction of group and recall). An examination of the means in Table 1 indicates that those in the text/text group performed substantially better than other groups on accuracy of post organizer/summary. This difference appears to largely disappear on ANS recall, and those in the text/text group had the lowest mean score on recall of material from the design passage. This result makes more sense when one considers the act of map/text or text/map translation more closely. The act of translating text into a textual summary is a more simple exercise than translating across processing modes, that is, from text to map or map to text. The latter most likely involves

more dual activation of spatial and verbal processing systems. A number of theorists have suggested that the processing of graphic displays involves the activation of both visual and spatial channels (e.g., Dansereau, 1989; Kulhavy, Lee, & Caterino, 1985; Schwartz & Kulhavy, 1981). Therefore it is not surprising that those in groups MT and TM would produce a less than accurate initial summary due to the difficulty of the text/map or map/text translation. This act of spatial/verbal translation is not necessarily detrimental to eventual acquisition. It may, in fact, act to increase active and, thus, more schema driven processing, and/or it may help to produce a more robust dual trace in memory (Abel & Kulhavy, 1986; Dean & Kulhavy, 1981; Kulhavy et al, 1985; Schwartz & Kulhavy, 1981). Thus, it is not surprising that the advantage of the text/text group is largely gone by ANS recall. Lastly, the advantages of the map groups on transfer recall, albeit not significant, suggest that preexposure to knowledge maps (either student- or expert-generated), may serve to help students in the processing of subsequent expert-generated maps relative to students who have not received such preexposure.

Surprisingly, the accuracy of the postorganizer was not a significant predictor of the recall of the material for which the organizer was created. This is inconsistent with previous research that has found such organizers effective (Moore and Readence, 1980; 1984). This finding might initially lead us to believe that it is the process of making the organizer, rather than the accuracy of its representation, that has the biggest impact on eventual acquisition of the material. However, the effect appears to be strongly dependent on experimental condition. The results of the regression, and consideration of the zero-order correlations as a function of group

indicate that the organizer-recall relationship for those in the MT group was quite strong, moderate - at best - for those in group TT, and nonexistent for those in group TM. It is probably the case then, that the nature of the map/text translation and its congruence with the criteria measure is a powerful determinant in the organizer/acquisition relationship. When a graphic organizer is employed, the translation of that organizer into some type of verbal format is often crucial. (e.g., When students learn something for a test through some graphical study technique they are usually required to demonstrate their knowledge in a more formal traditional/verbal format at test time.) Those in group MT who produced accurate organizers demonstrated the ability to make such a transition, and this was significantly related to subsequent recall. The ability of those in the text/map group to produce organizers that accurately represented the material was largely unrelated to recall. Ability to translate text into a spatial organization appears to be unimportant for subsequent recall, if such recall requires a retranslation to a more traditional verbal output.

Taken as a whole, the present results indicate, that at least under some conditions, there exists little overall difference in text acquisition between students who study an expert-generated, student-generated map, or traditional text. However, the results were strongly suggestive of a more complex explanation, as moderated by the nature of the criteria variables applied. While text may serve to produce more accurate organizers, this difference appears to disappear with respect to initial acquisition, while maps may even be advantageous in terms of transfer to the processing of maps in the future. Moreover, the nature of initial exposure to the maps appears to serve as a strong moderating variable in determining the

relationship between post organizer production and acquisition of the material that the organizer represents.

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Table 1

Recall as a Function of Experimental Group

	Recall		
Group	Summary	ANS	Design
Map/Text			
M	.21	.14	.13
SD	.05	.08	.09
Text/Map			
M	.21	.12	.13
SD	.10	.07	.10
Text/Text			
M	.26	.17	.11
SD	.05	.07	.07

Table 2

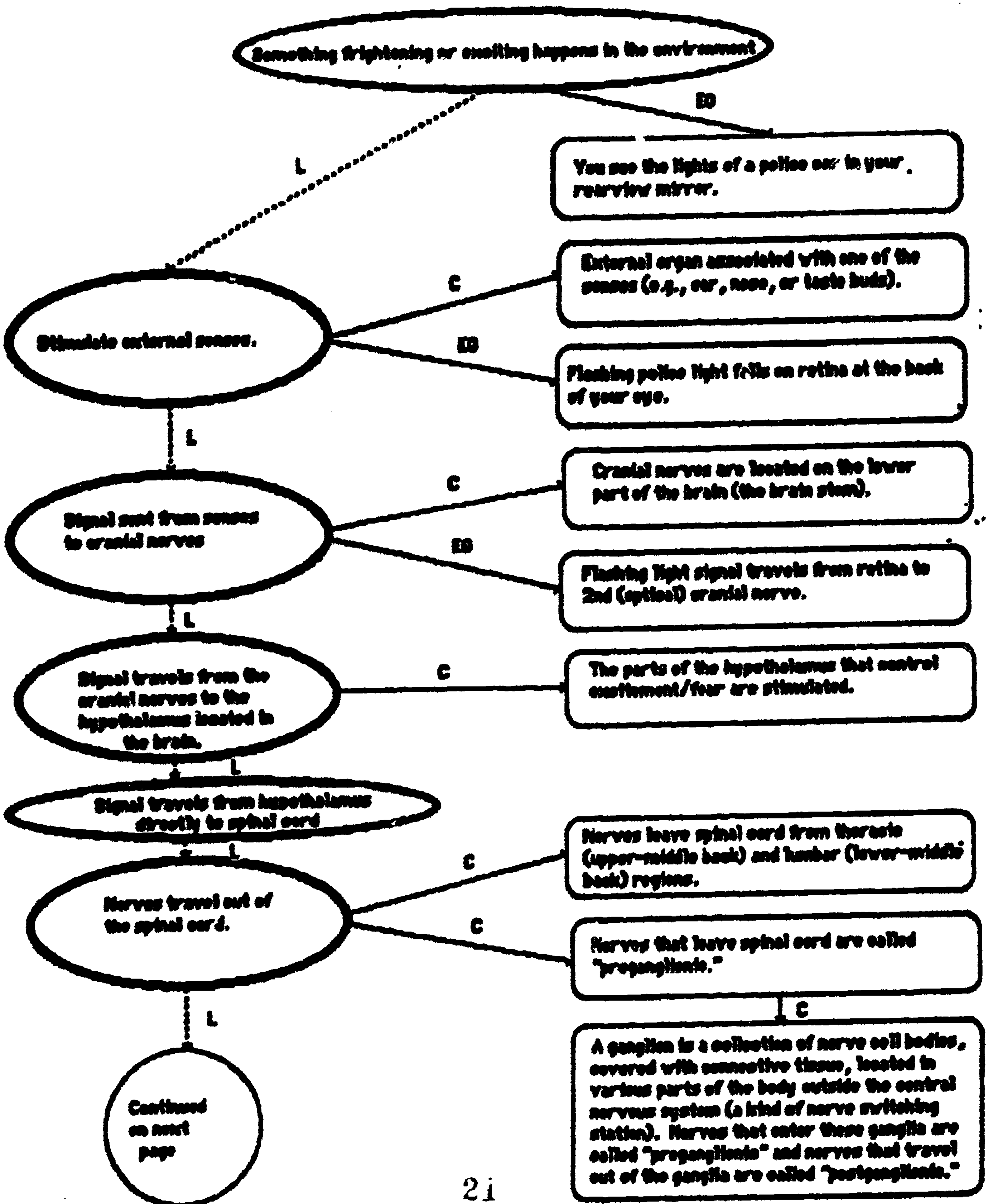
Regression equation constructed to predict ANS recall

Variable	R^2 change	F change	Probability
Group	.04	1.22	.30
Summary	.05	3.12	.08
Summary X Group	.11	3.34	.04

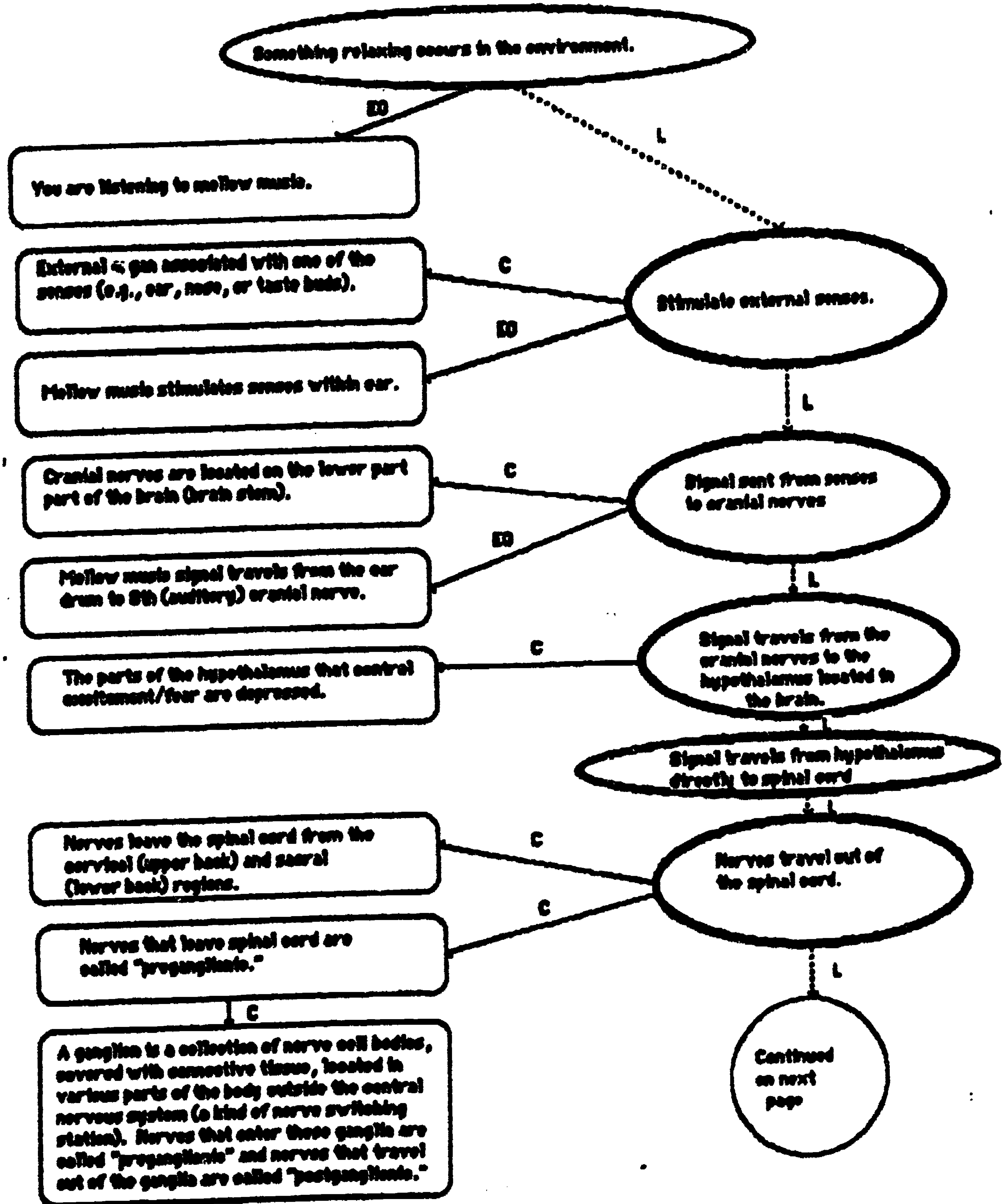
note: variables entered in a step-wise fashion in the order shown.

Figure Captions

Figure 1. A portion of one of the knowledge maps used in the present experiment (reduced in size from 11 X 17).



Something frightening or exciting happens in the environment
ED
You see the lights of a police car in your rearview mirror.
L
C
External organ associated with one of the senses (e.g., ear, nose, or taste buds).
Stimulate external senses.
ED
Flashing police light falls on retina at the back of your eye.
L
C
Cranial nerves are located on the lower part of the brain (the brain stem).
Signal sent from senses to cranial nerves
ED
Flashing light signal travels from retina to 2nd (optical) cranial nerve.
L
Signal travels from the cranial nerves to the hypothalamus located in the brain.
C
The parts of the hypothalamus that control excitement/fear are stimulated.
L
Signal travels from hypothalamus directly to spinal cord
L
C
Nerves leave spinal cord from thoracic (upper-middle back) and lumbar (lower-middle back) regions.
Nerves travel out of the spinal cord.
C
Nerves that leave spinal cord are called "preganglionic."
C
A ganglion is a collection of nerve cell bodies, covered with connective tissue, located in various parts of the body outside the central nervous system (a kind of nerve switching station). Nerves that enter these ganglia are called "preganglionic" and nerves that travel out of the ganglia are called "postganglionic."
L
Continued on next page


Something relaxing occurs in the environment.
EO
L
You are listening to mellow music.
External organ associated with one of the senses (e.g., ear, nose, or taste buds).
C
Stimulate external senses.
EO
Mellow music stimulates senses within ear.
L
Cranial nerves are located on the lower part part of the brain (brain stem).
C
Signal sent from senses to cranial nerves
EO
Mellow music signal travels from the ear drum to 8th (auditory) cranial nerve.
L
C
The parts of the hypothalamus that control excitement/fear are depressed.
Signal travels from the cranial nerves to the hypothalamus located in the brain.
L
Signal travels from hypothalamus directly to spinal cord
L
Nerves leave the spinal cord from the cervical (upper back) and sacral (lower back) regions.
C
Nerves travel out of the spinal cord.
C
Nerves that leave spinal cord are called "preganglionic."
L
C
A ganglion is a collection of nerve cell bodies, covered with connective tissue, located in various parts of the body outside the central nervous system (a kind of nerve switching station). Nerves that enter these ganglia are called "preganglionic" and nerves that travel out of the ganglia are called "postganglionic."
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