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The effect of near versus far domain analogies on learning and memory

Shirley Joyce Rhyne

THE EFFECT OF NEAR VERSUS FAR DOMAIN ANALOGIES ON LEARNING AND MEMORY

A Thesis

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Approved:

[redacted] 6/27/90

Diane F. Halpern, Ph.D., Chair Date

[redacted]

David M. Riefer, Ph.D.

[redacted]

Ellen N. Junn, Ph.D.

ABSTRACT

The effect that analogies have on the learning and memory of scientific information was the focus of this study. Four different analogies were combined with passages on climate and blood. These test stimuli were selected through a pilot study where students rated six passages with four analogies each. The analogies were far domain, high imagery; far domain, low imagery; near domain, high imagery; and near domain, low imagery. One hundred eighty subjects took a paper-and-pencil test after reading the passages. Twenty subjects were randomly assigned to the control group who read the passages without analogies. The other 160 subjects read the passages with one of the four analogies at the end of each passage. Then they rated themselves on prior knowledge of the subject material, comprehension and amount learned. The dependent measures were five cued-recall questions, two inference questions, a new analogy to solve, free recall, and spontaneous mention of the analogy. Results failed to support the hypothesis that far domain analogies would facilitate learning and memory better than near. Results also failed to support the secondary hypothesis that high imagery analogies would facilitate learning and memory better than low.

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INTRODUCTION

Analogies have been used and studied for literary and explanatory purposes since Aristotle's time. They have been used to measure intelligence, critical thinking abilities, and conceptual thinking level. However, as Halpern (1987) has pointed out, only a few studies have measured the extent to which analogies actually facilitate comprehension, recall and learning.

There are many definitions of analogies, which usually reflect the author's theory of their function. Dreistadt (1968) distinguishes between analogy and metaphor by defining analogy as a form of sensory imagery, and metaphor as an analogy in verbal form. In this paper, the term "analogy" is used as D. Gentner (1982) has defined it, as ". . . a neutral term for any non-literal similarity comparison" whether it is called a metaphor or an analogy (pp. 107-108).

Marschark and Hunt (1985) define analogy as a kind of sentence where two objects are compared non-literally. Poze (1983) describes an analogy as having three parts--a subject, an analogue, and a connection. He believes that the analogy's connection is the most important part, because it establishes the meaning of the analogy. Hesse (1966)

describes an analogy as having two dimensions: horizontal, which are similar aspects of each subject domain, and vertical, which are causal relationships. The analogy transfers similar aspects and causal relations from the secondary to the primary system, and these implications then select or suppress features of the primary system.

Holland, Holyoak, Nisbett, and Thagard (1986) agree with Hesse and state that the impact of an analogy often makes two ideas seem more alike than they did before by picking out abstract characteristics that they share. Oppenheimer (1956) describes the similarity as one of structure, form, or constellation between two things that are actually very different but have parallels in structure. Keane (1988) defines analogy as a "product" of particular cognitive processes that select certain aspects of one conceptual structure domain and match it with another domain. He also stresses the importance of relationships over attributes. All of these authors suggest that analogy involves processing at a deeper level.

The accent on the structure and the relationships in the structure are of particular importance to the present study. While other definitions and theories have touched on this, D. Gentner's (1982) concern with underlying structures and the syntax of the relationships are specifically relevant. D. Gentner concurs with the above authors in her

definition that an analogical comparison exists when the relationships correspond but the objects do not. For instance, the analogy of the solar system is used to describe the structure of the atom. Obviously, the parts of the solar system do not correspond to the parts of the atom. But the relationships between the planets and the sun are similar to the atom's parts. Similarly, her analysis suggests a deeper level of processing since the relationships exist at a deeper level than the attributes or the objects.

Analogical Reasoning

Many of the definitions of analogy cited above propose that analogical reasoning may be a process closely related to concept formation. Several authors have suggested that this process may be a way of examining underlying knowledge structures. For instance, Halpern (1987) describes analogies as ". . . creating complex schemata and concrete images . . ." and points out that analogies are a way of more readily studying the underlying knowledge structures (p. 81). Furthermore, Rumelhart and Abrahamson (1973) have built a model of analogical reasoning based on their conviction that analogical learning involves naturally occurring concept formation. They call attention to three measures usually used for the extent to which concepts have been

learned: (1) the ability to solve analogies; (2) judgments of dissimilarity; and (3) verbal descriptions showing the completeness of the concept. The ability to solve analogies and judgments of dissimilarity obviously involve analogical reasoning.

Holland et al. (1986) call analogy a powerful inductive process that brings experience to unfamiliar domains in order to make hypotheses and plans. Keane (1988) also believes that analogical processes are basic to concept formation and cites many examples in everyday language where the concrete is applied to the abstract. For instance, happy is considered up, and sad is considered down. He describes analogical thinking as using concrete prior experience which in turn also uses a more abstract prior knowledge. Therefore, analogy can be a very useful tool in the instruction of sciences and in theory development.

Gick and Holyoak (1980) propose that there is great similarity between the process of forming analogies and the concept of "schema." This similarity consists in the fact that they both contain a systematic organization of relations. Gick and Holyoak also propose that analogies have many levels of abstraction and that rules of inference can generate more and more abstract systems of learning or "macrostructures" (Gick & Holyoak, 1980). Macrostructures are described as summaries of experience or learning that

exist at many levels of abstraction. The difficulty lies in determining the optimal level of abstraction for the analogy in order to be of maximum practical use (Gick & Holyoak, 1980). For instance, if the abstraction becomes too abstract, it may be too general and lose its effectiveness.

D. Gentner (1983) suggests that the analogical process is a system of structure-mapping. Structure-mapping involves taking the relationships in one area of knowledge and laying them over the new area to match the similarities. Gick and Holyoak (1980) also theorize that an analogy consists of mapping between two areas of knowledge or two relational systems or domains. Abstracting these relations from instances may involve a similar process of mapping. Gick and Holyoak propose that the optimal level of abstraction for an analogy can be determined by the highest degree of correspondence of relations reached between two systems. For example, the problem of the laser as a treatment for a tumor. In order to destroy the tumor, so much laser beam strength would have to be used that the other tissues would be damaged. The analogical problem is the conquering of a city that has numerous roads into it but is surrounded by a wall. The solution is to use laser beams at a weaker strength from many directions and thereby destroy the tumor. Comparing this to the city, the similarities and the differences are obvious. The many roads into the city

correspond to the many laser beams. To realize the similarity, a subject must be abstract enough to ignore the concrete differences. Attaining an optimal level of abstraction can be difficult. Gick and Holyoak's research shows that this difficulty is compounded by the considerable variation in the amount of mapping done by subjects for an analogous solution.

Effects of Analogy

Most of the definitions included within this study have described the properties of analogies. These properties are usually theorized to facilitate learning and memory, either directly or indirectly. Sticht (1979) states that analogies extend the limitations of memory by enabling the person to encode information in a structure. Dreistadt (1968) believes that their use decreases the amount of imagery needed to understand a problem, because the whole solution can occur in that flash of insight commonly experienced. Analogy can thus serve as a sort of shorthand in imagery and understanding.

Poze (1983) believes that analogies fuse ideas and that the core of analogical thinking is the way they mix and reinforce images. Sticht (1979) describes analogy as a tool for thought that extends the capacity for perceiving relationships in the perceptual domain to the conceiving of

relationships in the conceptual domain. He cites several studies where pre-adolescents and marginally literate adults were readily taught to use analogies. He concludes that the use of analogies is not a new mode of thinking for them. What education does, he suggests, is increase the range of situations in which categorization is used. Educated people look for relationships in many more situations, because they have a wider range of ways that objects, events and processes can be related.

Petrie (1979) agrees with Sticht and claims that analogy is one of the main methods for bridging the gap between old knowledge and new. An analogy tells the listener to look at this new situation the same way as the old one. Halpern (1987) also refers to this effect that analogies have of "making the unfamiliar known" (p. 85). Sticht (1979) points out, in the same vein, that an analogy gives a clue as to how to think about two areas of knowledge or two concepts.

D. Gentner and D. R. Gentner (1983) hypothesize that ". . . analogies are used in generating inferences" (p. 100). The way an analogy is understood, Tourangeau (1982) states, takes four steps: recognizing the analogy, inferring the subjects, creating parallel beliefs, and comparing these beliefs to old ones. Sticht (1979) believes that in the process of relating information in the first domain to

the second, another knowledge structure is created consisting of the relationships which hold between the two domains. Here again is the suggestion that analogical processing underlies concept formation. Tourangeau's parallel beliefs are hypotheses, and Sticht's new knowledge structure consists of new concepts formed from relating the two domains.

Simons (1984) outlines the analogical process as having three functions--concretizing, structurizing and active assimilation--and found support for all three of these functions in several studies. The concretizing function relates to making ideas more vivid and imaginable. The structurizing function provides an organized place for the new information. The active assimilation function infers that analogies stimulate active learning.

Petrie (1979) proposes a function similar to active assimilation and says that analogy provides a mechanism for changing our way of representing the world by involving the student actively in understanding an interactive metaphor. It does this by creating an anomaly, the parts of the analogy that do not fit, and involving the student in reorganizing and changing his or her framework of understanding. However, the idea of the interactive metaphor or analogy actually originated with Richards and was developed by Black (cited in Martin & Harre, 1982). Black's

Interactive Theory of Metaphor suggests that the two subjects of the metaphor interact and that one acquires new meaning because of its involvement with the other. The subsidiary subject or base domain reorganizes thought in a new way (Martin & Harre, 1982).

Petrie's (1979) active function of analogy that involves the student in reorganizing his or her own structures of information is particularly relevant to education. Dreistadt (1968) points out that analogies that are used initially in formulating creative concepts can also be used to ". . . popularize a science when writing for nonscientists and to help teach the sciences to students" (p. 115). Perkins (1983) concurs that analogy is a resource for the student who has very little technical knowledge. Poze (1983) and Halpern (1987) also point out the use of analogy to help conceptualize a problem and to relate it to subject matter that is familiar to the beginner.

Ortony (1975) proposes three theses of how analogy facilitates learning: the compactness thesis, the vividness thesis, and the inexpressibility thesis. The compactness thesis proposes that language comprehension is a reconstruction process and that analogy enables comprehension without the necessity of going through all the details. The vividness thesis states that analogy is closer to perceived experience and, therefore, enables a communication of richer

detail in all the senses as well as emotive power. The inexpressibility thesis proposes that there are some things that are not describable, such as words in one language that cannot be accurately translated to another. Analogy can provide a way to convey a whole realm of information beyond the few words contained in the analogy itself.

Ortony believes that analogy is an essential part of communication and, therefore, valuable to the educational process. He proposes that there are two parts to the educational power of analogies: first, the vivid imagery resulting in memorability and better understanding; and, second, a device for moving from familiar to less well-known.

Theories of Analogy

Some authors limit the definition of analogy to a mere similarity comparison. Others believe that similarity is only part of what is happening. The theories about analogical thinking covered in this section differ mainly in the author's concern with semantic structuring versus syntactic structuring. For instance, the definition of analogy as a similarity comparison concentrates on the individual attributes of the things being compared, like the tiny size of the atom or the hot temperature of the sun. Both of these attributes would not be included in the

similarity mapping. Gick and Holyoak (1983) describe four types of mapping relations involved in the analogy process: (1) identities, (2) indeterminate correspondences (things not yet mapped), (3) structure-preserving differences, and (4) structure-violating differences. As mentioned before, Gick and Holyoak (1980) describe the process as involving many levels of abstraction.

Rumelhart and Abrahamson (1973) represent one side of this spectrum of theories. They have constructed a model beginning with the premise that the memory structure can be represented as a grid. They describe a "multidimensional Euclidean space" that Henley has proposed (Rumelhart & Abrahamson, 1973). They believe that analogical reasoning depends on the structure rather than the content of the memory, meaning that analogical reasoning involves the organization rather than what you know. They describe the process of analogical reasoning as a kind of similarity judgment measured by the "psychological distance" between the conceptual domains in this structure and by the direction of the differences. This means that if the differences are in the opposite direction, the similarity is considered less than if they were at right angles or closer. They presented three experiments that support their theory. The best analogy represents sets of concepts embedded on a multidimensional similarity grid with a similar structure to

the problem to be solved. For example, if the structure of the problem had to do with wild animals such as tigers and elephants, the similar structure might include wild, ferocious, large, Asian, etc. In spite of this potentially useful model they have presented, Rumelhart and Abrahamson's proposed structure of memory has been criticized as being too simplified a model of memory structure to encompass the more complicated analogies. Most analogies are more complicated than just one word comparisons. Usually, an analogy involves a short story of experience.

D. Gentner's "structure-mapping theory" represents a the attempt to deal with the more complicated analogies. With a similar conception of structure in memory, D. Gentner and D. R. Gentner (1983) submitted that ". . . a structure-mapping analogy asserts that identical operations and relationships hold among nonidentical things" (p. 102). D. Gentner's research concentrates on the hypothesis that analogical processes provide a structure for understanding new schema. This conceptual role of analogy was investigated in an experiment about analogies on electricity (D. Gentner & D. R. Gentner, 1983), which demonstrated that different analogies can affect the conception of the new knowledge by generating different inferences. It does this because of the parts of the analogy that do not fit the structure of the new information. Their experiment involved

using two analogies to explain electricity. The analogies were flowing water in a hose and a large crowd going down corridors. Flowing water has properties that are different from electricity, and these differences caused subjects to make mistakes when they generated inferences about electricity based on their knowledge about flowing water.

The function of providing a structure for new knowledge is basic to D. Gentner's structure-mapping theory. Her goal is to provide a structural characterization of analogy in science and to propose that a science analogy is best represented as structure mappings between areas of knowledge. She maintains that an analogy ". . . conveys a system of connected knowledge. . ." (D. Gentner, 1983, p. 162). This system of connected knowledge can be termed the domain. She designates the base domain as the familiar domain of knowledge and the target domain as the new, abstract domain of inquiry.

D. Gentner's theory represents another side of the spectrum of theories with Rumelhart and Abrahamson on the other side. The major difference is that Gentner (1982) makes a strong distinction between objects and their attributes, on one side, and relationships on the other. An overlap in relations between two domains is a requirement for a perception of similarity whereas overlaps in both relationships and objects is literal similarity. Rumelhart

and Abrahamson (1973) would agree with the accent on relationships, but they describe this as exact distances on their grid between the elements of the analogy and similar distances between the elements of the problem. Essentially, Rumelhart and Abrahamson are more concerned with semantics than with syntax. Similarly, Gick and Holyoak (1980) describe domain distance as "semantic distance," but they agree with D. Gentner about relations being more important. Their proposals about abstraction levels and macrostructures in analogies and about schema-building seem more in agreement with D. Gentner's emphasis.

Keane (1988) observes that D. Gentner's structure-mapping process is mostly controlled by the syntax rather than the semantics. D. Gentner (1983) states clearly that ". . . the rules depend only on syntactic properties of the knowledge representation, and not on the specific content of the domains" (p. 155). This is supported in D. Gentner's research, because most of the subjects mention relations in interpretations of analogies rather than attributes.

Research on Apt Analogies

D. Gentner's (1982) research was also concerned with determining what characteristics of analogies are important to comprehend and remember scientific knowledge. Keane (1988) proposes that the effectiveness of analogy in

facilitating learning depends on what you want to teach in how much detail. D. Gentner's list of characteristics defines the difference between science or explanatory analogies and literary analogies. Science analogies are used for explanation and prediction and, therefore, require different characteristics than literary analogies.

Clarity and Comprehensibility. D. Gentner's (1982) research investigated the differences between science analogies and literary analogies. Her results show that science analogies are rated high in clarity and low in richness. She defines richness as "predicate density" or the quantity of predicates imported into the target domain. Predicates can be attributes or relations. Clarity is the exactness of the mapping of a set of base predicates onto the target with no two relations overlapping.

Comprehensibility, similar to clarity, was found by Tourangeau (1982) to be related to the aptness of an analogy. Johnson and Malgady (1980) found that the "best" analogies are those with only a single meaning. Tourangeau and Sternberg (1981) also found a relationship between comprehensibility and aptness.

Science analogies were also higher in abstractness, systematicity, and base specificity in D. Gentner's (1982) research. Base specificity refers to how well the base is understood or comprehended. Systematicity refers to how

much the transferred predicates are limited by the conceptual system of the base. Abstractness refers to the higher order relations of the imported predicates and is related to systematicity in that very systematic mappings are usually very abstract. Therefore, explanatory analogies that are high in clarity, systematicity and abstractness will be more effective in contributing to learning and memory. The findings about systematicity and abstractness support D. Gentner's theory and its accent on structure-mapping and looking at deeper structures.

Imageability. D. Gentner's results seem to be contrary to other research on imageability and vividness. Abstractness and imageability or vividness would seem to be contradictory. Riechmann and Coste (1979) argue that imagery is a shallow level of processing and that analogies require a deeper level of processing to interpret. They speculate that it is the "peculiar combinations of semantic domains" that produces the effect of analogies on comprehension and memory (Riechmann & Coste, 1979, p. 199). Anderson (1978) also argues that imagery is a shallow level of processing that can be distracting in analogies.

Contrary to these researchers, several sources, previously cited, have mentioned imageability and vividness as more memorable (Poze, 1983; Simons, 1984). Petrie (1979) refers to Paivio's research as evidence of the effect of

imageability on memory or learning. Several researchers have demonstrated the impact of imagery on memory (Howard, 1983). Myers (1986) also points out that "concrete, high-imagery words (words that lend themselves to picture images) are better remembered than abstract low-imagery words" (p. 250-51). "The imagery principle" is explained as having an excellent memory for pictures and words that produce pictures; this principle can be applied in teaching and writing (Myers, 1986). Ortony's (1975) vividness thesis proposes that analogies are particularly vivid, because they are so close to sensory experience and call up a "richness of detail" with just a few words (p. 50). He also adds that the vividness is not restricted to the senses alone but extends to the emotions as well.

Marschark and Hunt (1985) agree that topic imagery produces consistently reliable effects on memory by extending it. They found that the imagery of a subject was a reliable predictor of recall in all 15 independent conditions of their experiments. Halpern (1987) agrees and adds that analogies to concrete objects can be a visual-imagery mnemonic aid and can make abstract concepts more concrete by providing a mental image.

Familiarity. Both familiarity and novelty are characteristics of good analogies. In order for the analogy to facilitate learning and memory in the new knowledge, the

base domain of knowledge in the analogy must be familiar to the reader. However, Poze (1983) cautions about using analogies that are so familiar that they are self-evident and have no impact on memory. Yet, on the other hand, novel analogies may not be understood; because the information in the analogy may be totally unfamiliar and, therefore, does not provide a structure for the new knowledge. Therefore, familiarity and novelty must be in a kind of balance.

Similarity. The above problem of balancing a characteristic exists for similarity also. D. Gentner (1983) proposes that the difference between an analogy and literal similarity is a ". . . continuum, not a dichotomy" (p. 161). Tourangeau and Sternberg (1981) suggest that analogies fail for two reasons that they are either too obscure or too dull. When you make the analogy too similar to the new knowledge domain, it is very clear but also very dull. Similarity, then, increases both clarity and dullness. Marschark and Hunt (1985) call this characteristic "semantic relatedness" and rate it for closeness in meaning from low similarity to high similarity. They conclude that high similarity is important for interpretation of an analogy but, for memory, may even interfere because the interpretation is too obvious and may be ignored. The value of an analogy, they have decided, is in the imagined similarities that sometimes requires more general conclusions.

Domain Distance. Tourangeau and Sternberg (1981) list several hypotheses relevant to the characteristics of both similarity and domain distance: (1) comprehension is easier when target and base domain are more similar; (2) as target and base domains are less similar, novelty increases; (3) when target and base domains are neither very similar nor very dissimilar, metaphors are more apt; and (4) when target and base are from less similar domains but occupy more similar positions within the domains, metaphors are more apt. Their results showed that as the domains of the analogy and new knowledge are more dissimilar, the analogy is more striking and considered more apt.

Tourangeau and Sternberg (1981) propose that similarity has two components: congruence of the domains and agreement between projected and prior beliefs. They conducted a study to test these two components and found that subjects preferred analogies drawn from distant domains and analogies that confirmed their picture of the principal subject. They also define two kinds of novelty, "new beliefs in a new package," and found that they seem to depend on the two components of similarity. Novelty shows the lack of congruence between the domains and also the lack of agreement. For instance, remember the analogy of the tumor and the walled city, the novelty of this analogy consists in comparing two things that are from very different knowledge

domains--a human body and a walled city--but these very differences can prevent a transfer of the knowledge structure. Consider penetrating a wall and penetrating the skin of a body.

Tourangeau and Sternberg refer to two components of similarity as between-domain versus within-domain. They believe that this is the crucial distinction that determines the aptness of an analogy. Tourangeau (1982) believes that it is the clash between domains, which may be semantic or a pragmatic anomaly, which catches the attention and makes an analogy memorable or apt. Incongruity may be the reason for this clash. Tourangeau and Sternberg (1981) report that incongruent analogies should "jolt us out of our usual way of seeing things" (p. 30). They conclude that the source of this jolt is the distance between the domains. They hypothesize that the target and the base must be from different domains but occupy similar positions within their domains in order for the analogy to be apt. Their results show that there is consistent support for the prediction that there is a negative relationship between within-domain distance and aptness. But there are only trends in the data to support the idea that targets and bases have asymmetrical roles. Therefore, analogies are considered more apt as long as they are in similar positions within domains that are not too close or too much alike.

Holland et al. (1986) agree with Tourangeau and Sternberg but conjecture that between-domain analogies are superficially very different even though they are perceived as basically abstract and systematically similar in the relations among component parts. They conclude that the similarities of the base and the target consist of abstract relations. This conclusion agrees with D. Gentner's research which says that it is the relations which are mapped, not the attributes or objects.

One final characteristic to be considered along with domain distance is the deep structure of analogies. Hofstadter (1981) observes that "deep analogies" are in single domains and also between domains. But deep analogies force a reanalysis and a generation of new rules and categories because of the usual surface differences of the domains. It may be that Hofstadter's deep analogies are more often found between domains and that it is the processing of these deep analogies that results in learning and better memorability. Deep analogies are usually far domain analogies. The creation of these deep analogies or the reanalysis may also be the process referred to above by several authors as primary to concept formation or the underlying knowledge structure. It is certainly comparable to Gick and Holyoak's levels of abstraction of analogies. Similar to levels of abstraction is Riechmann and Coste's

(1979) argument that analogies require going to a deeper level to interpret them.

Research on Domain Distance

Gentner's research (1982, 1983; D. Gentner & D. R. Gentner, 1983) has already been cited and has contributed greatly to the conception of this study. Hansen (1987) and Halpern, Hansen, and Riefer (in press) investigated domain distance in analogies as aids to understanding and memory. The analogies that Halpern, et al., used were either from near knowledge domains or from far knowledge domains. The term "knowledge domain" is defined as an area of information or a relational system of information. Near knowledge domains are defined as areas of knowledge that have great surface similarity, like sonar and radar. Both sonar and radar involve waves that bounce back when something is detected, and they are both used in detection devices. Far knowledge domains are defined as knowledge systems that are conceptually distant, because there are few surface similarities and few apparent connections between them. For instance, comparing rainbows to the mail sorting machine in the Post Office would be far knowledge domains. The deep correspondence of relationships that they share has to do with separating or sorting something. These things are in knowledge systems usually not considered together. Rainbows

are a naturally occurring part of the weather, and mail sorting machines are mechanical and manmade.

The results of Halpern's, et al., research showed that subjects who read a scientific passage that contained a far analogy did significantly better than when the passage contained a near analogy or no analogy. Subjects also indicated on self-ratings that they felt they learned more from passages with far analogies.

Several questions and concerns remained after this research was completed. One concern was the comparability of the analogies. The near and far analogies were applied to different passages. Hansen (1987) indicated that she had great difficulty obtaining good analogies, especially from near domains, or of obtaining comparable analogies for all three scientific passages. She suggested that the analogies should be rated for both for imageability and goodness as well as domain distance. She also suggested that far domain analogies were higher in imagery than analogies from a near domain.

The present study was based on the research by Halpern, Hansen, and Riefer and is attempting to answer some of these questions and concerns. The primary concern was for comparable analogies. These analogies must be comparable in terms of near or far knowledge domains. Secondly, these analogies must also be comparable in high and low image-

ability. A third refinement was to use these various analogies with the same scientific information. Therefore, if the analogies are comparable in domain distance and imageability and are used on the same scientific information, the individual effect of each of these factors on learning and memory could be measured.

Statement of Purpose

Based on the previous research on domain distance by Halpern, Hansen, and Riefer, the purpose of this study was to investigate the effect of far domain analogies versus near domain as well as high and low imagery analogies on learning and memory. In order to study these specific effects, it was necessary to determine that these factors were part of the analogies used. Marschark and Hunt (1985) believe that there is a need for more control in selecting analogies. Therefore, in this study, some of the characteristics of analogies, such as imageability, comprehensibility, and domain distance were rated in a preliminary study using a ten-point Likert scale on six passages, with each passage having four analogies. Based on these results, two passages were chosen according to their similar scores on imageability and domain distance as well as their scores on comprehensibility. These two passages were used in the main experiment. Each passage had one of four analogies

comprised of the combination of near and far domains and high and low imagery. Each passage also had no analogy condition as a control.

Learning and memory were measured by the number of facts freely recalled, the number of facts correct from cued recall, the number of inference questions answered correctly, the correct solution to the new analogy and the spontaneous mention of the analogy. Subjects were also asked to rate their previous knowledge of each subject, comprehension after reading the passage, and how much they learned from the passage.

Hypotheses. The main prediction was that far domain analogies would facilitate learning and memory better than near domain analogies, as measured by number of correct facts recalled in cued recall and free recall, correct inferences, correct solution to the new analogy and spontaneous mention of the analogy in free recall. Far domain analogies should create more impact on the reader, because he or she would look for the deeper structure of the information. Near domain analogies should be more likely to be as unfamiliar as the new knowledge of the scientific passage. Also, since near domain analogies would be more similar to the new knowledge, subjects presumably should not process them more deeply for the structure.

A second hypothesis was that analogies that are high in imageability would facilitate learning and memory more than analogies that are low in imageability, because imageability would make the new information more concrete and more vivid. This is consistent with Paivio's (1969) dual theory of memory. It is expected that an analogy from a far domain that is also high in imagery would be particularly helpful to learning and memory, since there would be both deep and surface processing. Subjects would look for the deeper structure and the relationships in the far domain analogy in addition to processing the surface structure of the imagery which would have the impact of being more concrete and vivid.

METHOD

This study was done in two phases. The first phase was to ascertain that the test analogies were comparable on imageability as well as domain distance. Therefore, during the first phase, subjects were asked to rate several analogies. Then, in the second phase, only those analogies with rater agreement on these two characteristics and high ratings on comprehensibility were used.

Phase I

Subjects. Forty-three adults, 36 females and 7 males, were recruited from both graduate and upper division psychology classes at California State University at San Bernardino. The age range was 19 to 50.

Materials. Six passages of scientific text on various topics, followed by four analogies, were collected into booklets. The six topics were (a) DNA, (b) electricity - Ohm's Law, (c) lymphatic system, (d) enzymes, (e) climate and (f) blood cells. The four analogies for each of these six subjects were: Near domain analogy with high image-ability, near domain analogy with low imageability, far domain analogy with high imageability, and far domain analogy with low imageability. The analogies were collected

from several sources, including college biology textbooks, physics textbooks and from Hansen's research. Because it was so difficult to find four analogies for each topic, some of the analogies were imaginary. For instance, the near domain, high imagery analogy for three types of blood cells was tree sap cells.

A ten-point Likert type scale was provided to determine prior knowledge for each of the six subjects (with 0 indicating "No Prior Knowledge" and 9 indicating "Professional-Level Knowledge"). Ten-point Likert scales were provided after each passage to determine amount learned (with 0 indicating "Almost Nothing" and 9 indicating "A Great Deal"). Three ten-point Likert scales were provided after each analogy for each of the following questions: (1) How much did the analogy help comprehension (with 0 indicating "Not At All" and 9 indicating "A Great Deal"); (2) How easy or difficult was it to form an image (with 0 indicating "Extremely Easy" and 9 indicating "Extremely Difficult"); and (3) Compare the topic of the passage with the topic of the analogy and indicate how closely related they are (with 0 indicating "Very Close" and 9 indicating "Very Far"). Finally, subjects were asked to rank the four analogies according to how useful they would be in learning about the topic on a scale of 1 to 4, with one being most useful to four being least useful. (See Appendix A.)

Procedure. The rating materials were handed out to subjects who took them home to complete. Some of the subjects were in psychology classes which gave extra credit for participating in this research.

The criteria used to select comparable passages and analogies were the students' ratings on imageability, domain distance and comprehensibility. The rating on question 1 above, how much did the analogy help comprehension, was used to indicate comprehensibility. Question 2, how easy or difficult was it to form an image, was used to indicate imageability. The rating on question 3, compare the topic of the passage with the topic of the analogy and indicate how closely related they are, was used to indicate domain distance.

Phase II

Subjects. One hundred eighty adults, between the ages of 18 and 67, were recruited from psychology classes at California State University at San Bernardino and from personal referrals in the community. There were 65 males and 115 females. Almost 90 percent of them had one year of college or more.

Since learning and memory were being tested, there was a need for highly motivated subjects. The experimental task required subjects to perform maximally. Consequently,

instructors were asked to give extra credit for participation in the experiment; and prizes were offered for the top three scores. Subjects were blind to the nature of the task. They were only told that it was a paper-and-pencil memory/ comprehension task.

The subjects were divided randomly into 5 groups, determined by which test booklet they received. Table 1 presents the order the booklets were distributed: (1) far domain, high imagery analogy and near domain, high imagery analogy; (2) far domain, low imagery analogy and near domain, low imagery analogy; (3) far domain, low imagery analogy and near domain, high imagery analogy; (4) far domain, high imagery analogy and near domain, low imagery analogy; and (5) no analogy control group. Appendix B contains the passages and analogies on climate and Appendix C the passages and analogies on blood cells.

Materials. Eighteen different booklets comprised the stimulus materials. Each booklet contained two passages of scientific text on the topics of blood cells and climate. Two booklets were control materials and contained no analogies for either topic. The other 16 booklets contained the two passages on climate and blood cells with an analogy at the end of each passage. The topics were counterbalanced for order effects. The booklets were varied systematically so that all combinations of domain distance and imageability

TABLE 1

List of Test Booklets

No.	Passage	Domain	Image	Passage	Domain	Image
1	Blood	near	high	Climate	far	high
2	Climate	far	high	Blood	near	high
3	Blood	near	low	Climate	far	low
4	Climate	far	low	Blood	near	low
5	Blood	near	high	Climate	far	low
6	Climate	far	low	Blood	near	high
7	Blood	near	low	Climate	far	high
8	Climate	far	high	Blood	near	low
9	Climate	near	high	Blood	far	high
10	Blood	far	high	Climate	near	high
11	Climate	near	low	Blood	far	low
12	Blood	far	low	Climate	near	low
13	Climate	near	high	Blood	far	low
14	Blood	far	low	Climate	near	high
15	Climate	near	low	Blood	far	high
16	Blood	far	high	Climate	near	low
17	Blood	No Analogy		Climate	No Analogy	
18	Climate	No Analogy		Blood	No Analogy	

were used in combination with the two passages. Table 1 is a list of the 18 test booklets in the order they were given out to subjects. Each booklet contained one near and one far domain analogy but could contain any combination of high or low imageability.

For the passage on blood cells, the analogies were as follows, (a) far domain, high imagery: red knights, white knights and bricklayers defending a castle, black knights invading the castle; (b) far domain, low imagery: three judicial principles--truth, liberty and the pursuit of happiness (an imaginary analogy); (c) near domain, high imagery: three kinds of tree sap cells functioning as the three kinds of blood cells (an imaginary analogy); and (d) near domain, low imagery: chemical processes in the brain--amino acids, lymphatic substances, and complex proteins (an imaginary analogy). (See Appendix B.)

For the passage on climate, the analogies were (a) far domain, high imagery: skipping a stone across a pond which is dependent on the angle the stone is thrown; (b) far domain, low imagery: philosophical arguments and whether they are directed to the point or directed obliquely around the point; (c) near domain, high imagery: infrared lamps in a cafeteria where food directly under the rays are warmer; and (d) near domain, low imagery: sonar mechanisms and the angle of the signals sent. All passages were of comparable

length except that the no-analogy passages were shorter. (See Appendix C.)

Three ten-point Likert scales were provided for (1) prior knowledge (with 0 indicating "No Prior Knowledge" and 9 indicating "Professional-Level Knowledge"), (2) comprehension after reading the passage (with 0 indicating "Not At All" and 9 indicating "Very Well"), and (3) amount learned from the passage (with 0 indicating "Very Little" and 9 indicating "A Great Deal"). Information was also requested about gender, age and educational level.

The dependent measures of memory and learning were: Five cued-recall questions, two inference questions, and a new analogy to solve. The five cued-recall questions contained a variety of short-answer questions and multiple choice. Finally, the last page was for free recall where the subject was requested to "list as many facts as you can remember about the passage you read on Blood/Climate." (See Appendix D.)

Procedure. Subjects were randomly assigned to groups by giving each one the next numbered test booklet as they volunteered. (See Table 1.) The order of the test booklets was repeated until booklet 180 was distributed.

Subjects were asked to read the instructions on the first page of the test booklet but were informed that the test would not be timed. They were also made familiar with

the format used for the new analogies. Subjects were tested singly or in small groups. Most subjects took approximately 20 minutes to complete the test booklet.

RESULTS

Phase I

The focus of this experiment was to test the effect of analogies that were comparable on domain distance and imageability on learning and memory. Therefore, passages and analogies were selected based on students' ratings on imageability and domain distance.

Table 2 presents means of students' ratings for imageability (Image), domain distance (Near-Far) and help on comprehension (Help). The ratings on help were used to indicate aptness or comprehensibility. The passages with the highest mean ratings for the four analogies on help were Blood Cells and Climate. The average mean rating for climate was 5.24 and for blood was 5.03. The means ranged from 4.15 to 6.525 for climate and from 4.2 to 6.45 for blood. The range of mean ratings for low imageability was from 4.65 to 5.625 and for high imageability was from 2.075 to 3.525. The range of mean ratings for near domain distance was from 3.6 to 4.925 and for far domain distance was from 5.3 to 6.475. None of the other passages showed this definite pattern or consistency in the ratings for near and far domain distance and for low and high imageability.

TABLE 2

Means of Students' Rating of Passages and Analogies

Analogy		Help	Image	Near-Far
Climate	A	6.525	2.275	5.575
	B	5.725	2.275	3.600
	C	4.150	4.650	6.475
	D	4.550	4.850	4.925
Blood	A	6.450	2.075	5.300
	B	5.150	3.525	4.075
	C	4.300	5.100	6.350
	D	4.200	5.625	4.475
DNA	A	4.400	3.975	5.450
	B	3.275	5.725	4.900
	C	4.950	4.450	5.500
	D	3.950	4.625	4.800
Electric	A	6.725	1.550	3.475
	B	3.775	3.150	3.800
	C	1.800	6.900	6.800
	D	3.700	4.375	4.750

TABLE 2 (Continued)

Analogy		Help	Image	Near-Far
Lymph	A	6.975	1.775	3.800
	B	3.600	5.200	4.800
	C	4.850	3.675	5.725
	D	3.950	4.675	3.550
Enzyme	A	5.975	2.025	5.500
	B	4.225	4.525	3.775
	C	4.500	4.050	5.650
	D	4.975	4.575	3.425

Note. Ratings were made on a ten-point scale in which: Help was 0 = Not At All to 9 = A Great Deal; Image was 0 = High to 9 = Low; and Near-Far was 0 = Very Close to 9 = Very Far.

Analogies: (A) Far Domain and High Imagery

(B) Near Domain and High Imagery

(C) Far Domain and Low Imagery

(D) Near Domain and Low Imagery

Phase II

Subjects Self-Assessments. Means were computed for subjects' self reports on prior knowledge, comprehension and amount learned. Figures 1-3 display these means for each passage as a function of the experimental conditions. For each figure, the near domain, low imagery condition is indicated by N-L, and the far domain, low imagery condition is indicated by F-L. High imagery is N-H for near domain and F-H for far domain. The control group is coded C. The exact means for each self-assessment along with their standard deviations, can be found in Appendix E.

There is an obvious difference on all three self-reports between the blood cells passage and the climate passage, no matter which analogy condition is considered. T-tests were done to compare the means for the total climate ratings to the total blood ratings on each of the three self-reports. The mean rating on prior knowledge for all the blood conditions was 3.86 compared to 2.68 for all the climate conditions a marginally significant difference, t (178) = 1.84, $p < 0.10$. The mean rating on comprehension for blood was 5.68 and for climate was 4.57, which was also significant, t (178) = 5.19, $p < 0.001$. The comparison of amount learned was also significant, t (178) = 3.97, $p < 0.001$ with the mean for blood 4.96 and for climate 4.08. Thus, the means for all three scales on blood were

Figure 1: Means for Prior Knowledge

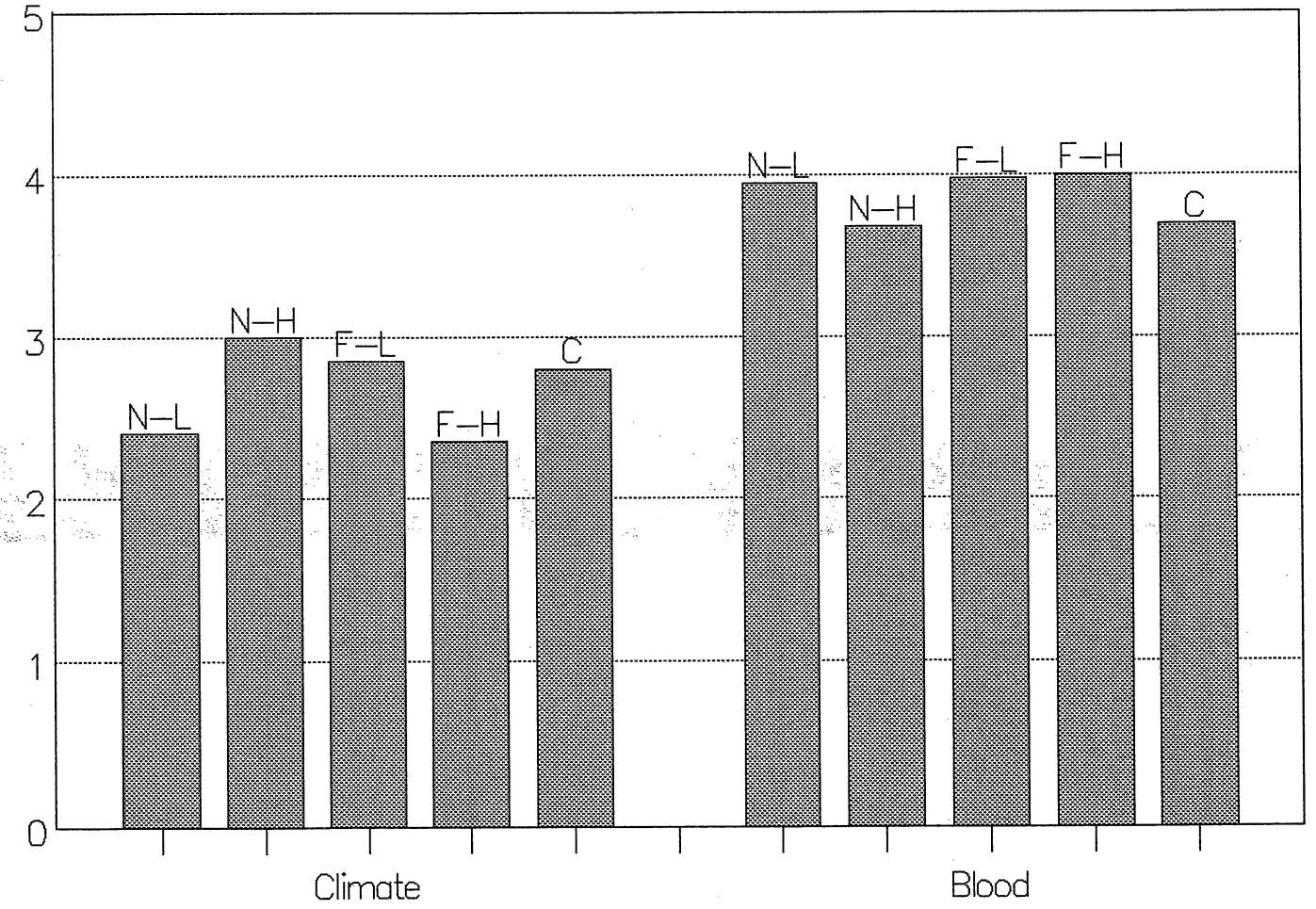


Figure 2: Means for Comprehension

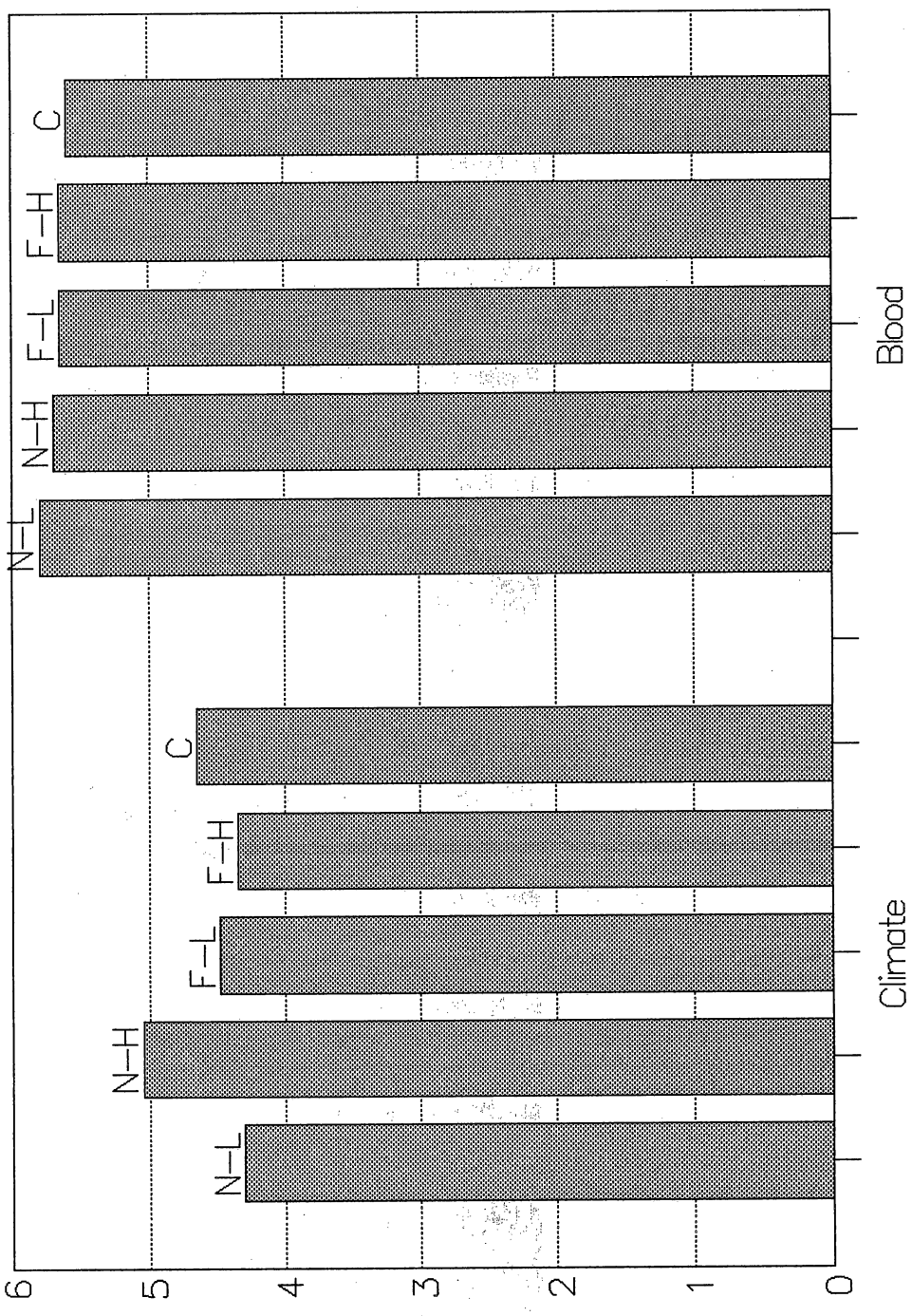
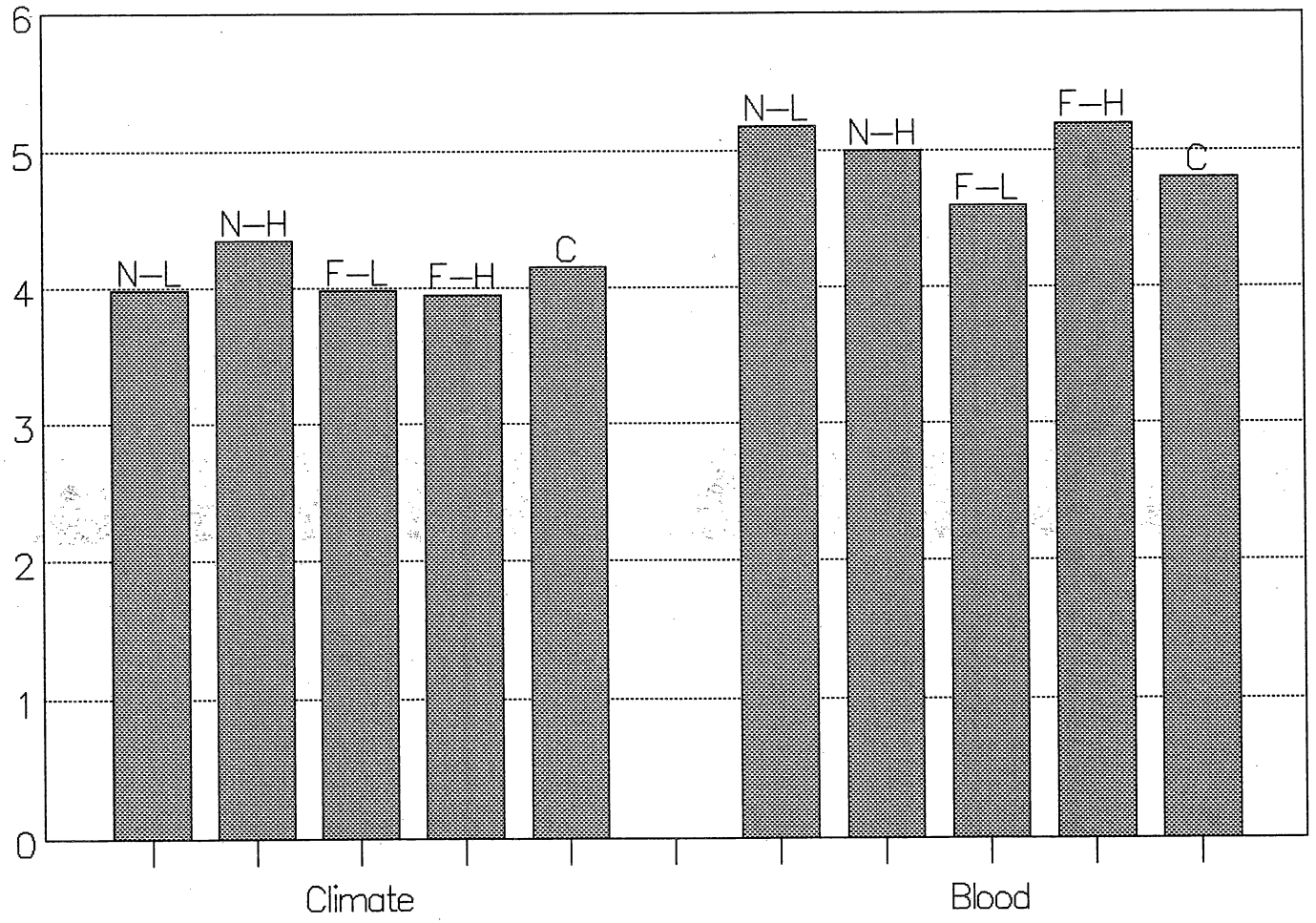


Figure 3: Means for Amount Learned



significantly higher than for climate. Evidently, subjects had significantly more prior knowledge about blood cells than about climate. They also indicated that they learned more from the blood passage and understood it better.

Dependent Measures. The four dependent measures consisted of cued recall questions answered correctly (out of a possible 5), inferences answered correctly (out of a possible 2), correctly solving the new analogy (scored as 0 = not solved, 1 = solved), and the number of correct facts in free recall.

An inspection of Figures 4-7 reveals that, here again, there was an apparent difference between the means for the blood passage and the means for the climate passage on all of these measures. Subjects' scores were much higher for blood than for climate. The exact means for each dependent measure, along with their standard deviations, can be found in Appendix F. One of the reasons for this difference was that 19 subjects left the response sheet blank. Five of these subjects left both the blood and the climate free recall response sheets blank, and 14 left only the climate free recall response sheet blank.

Similar to the self-reports, *t*-tests were done to compare the means for each of the four dependent measures for blood and climate. All four tests were significant. Subjects found the passage on blood cells significantly more

Figure 4: Means for Questions Correct

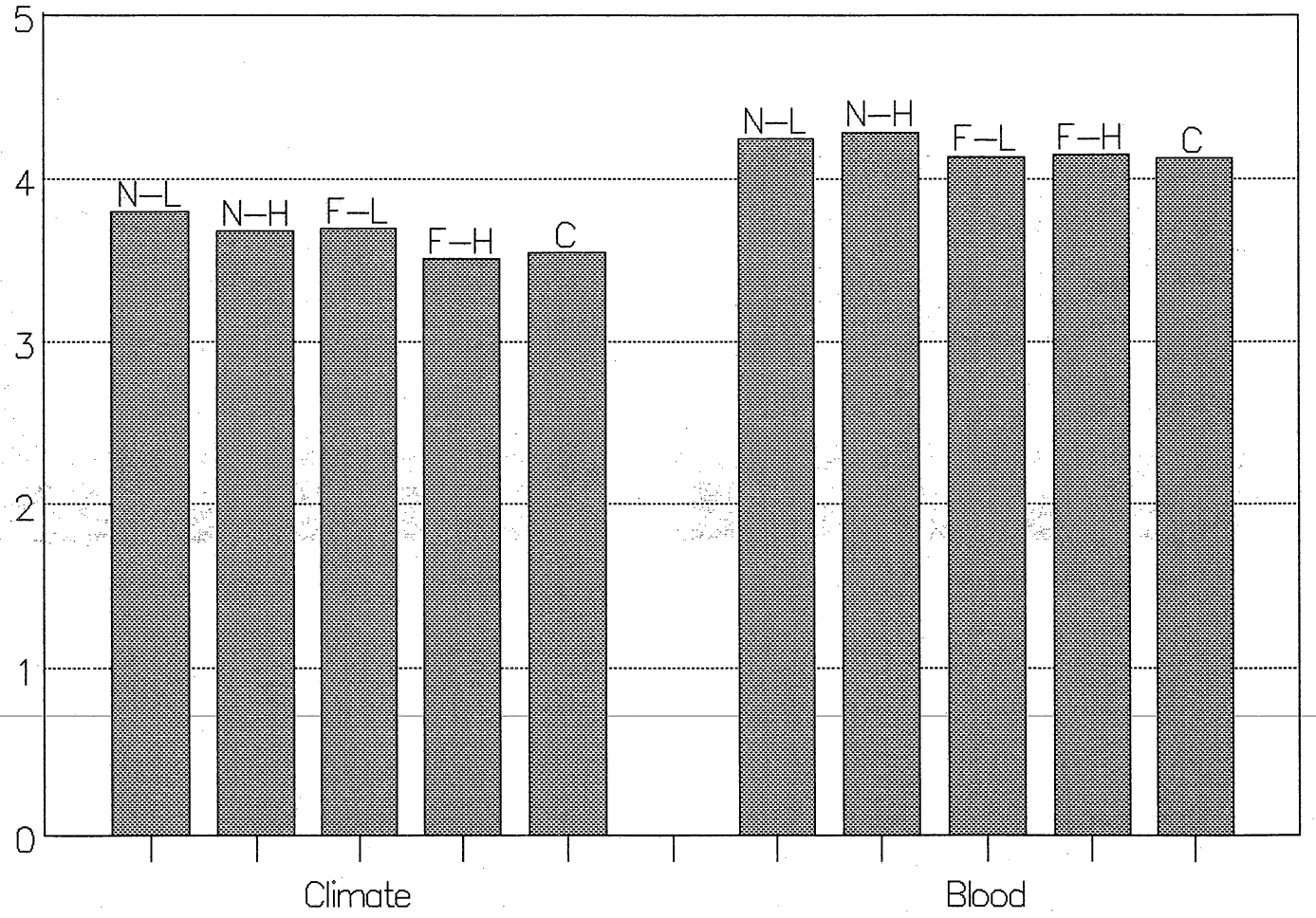


Figure 5: Means for Inferences Correct

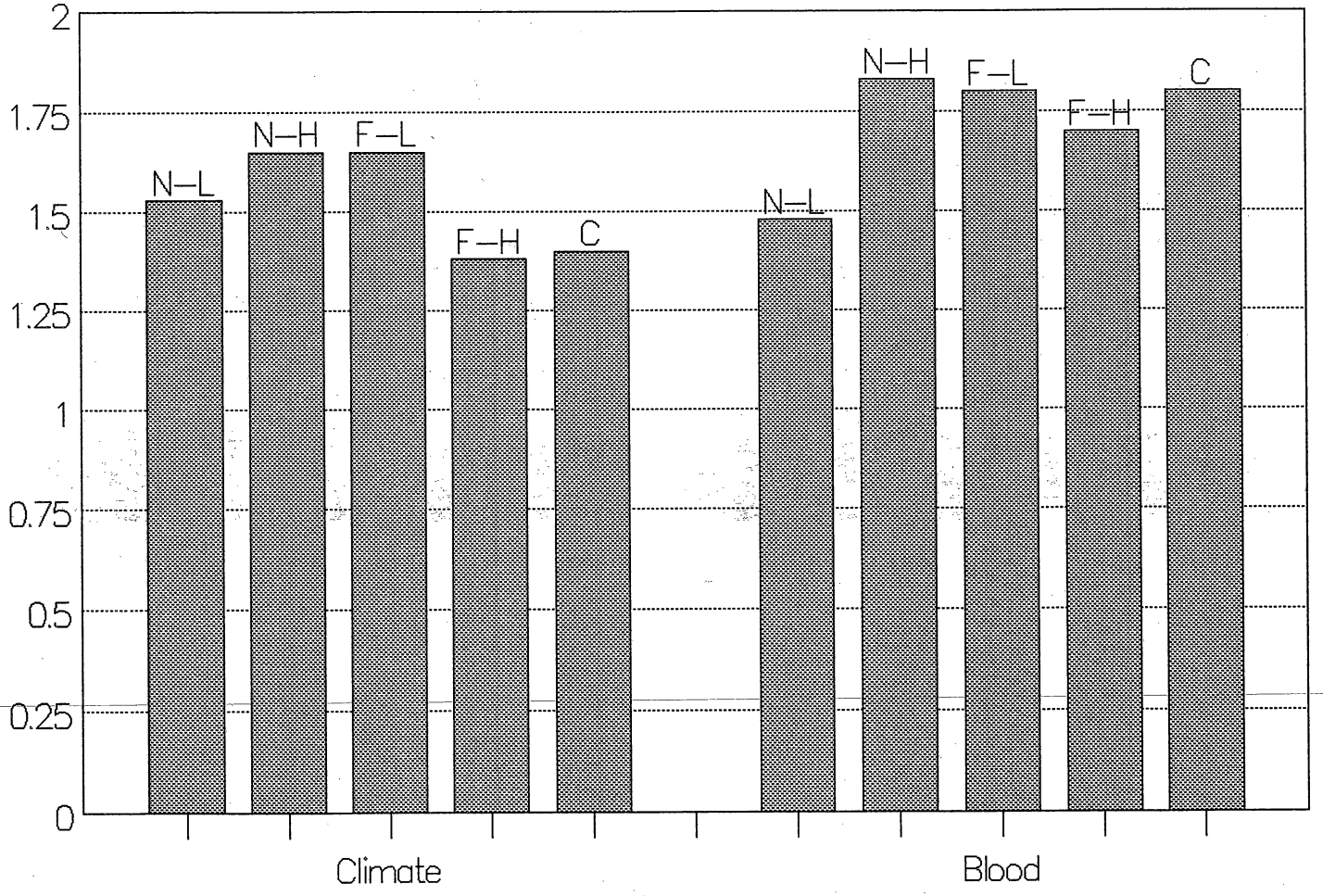


Figure 6: Means for New Analogy

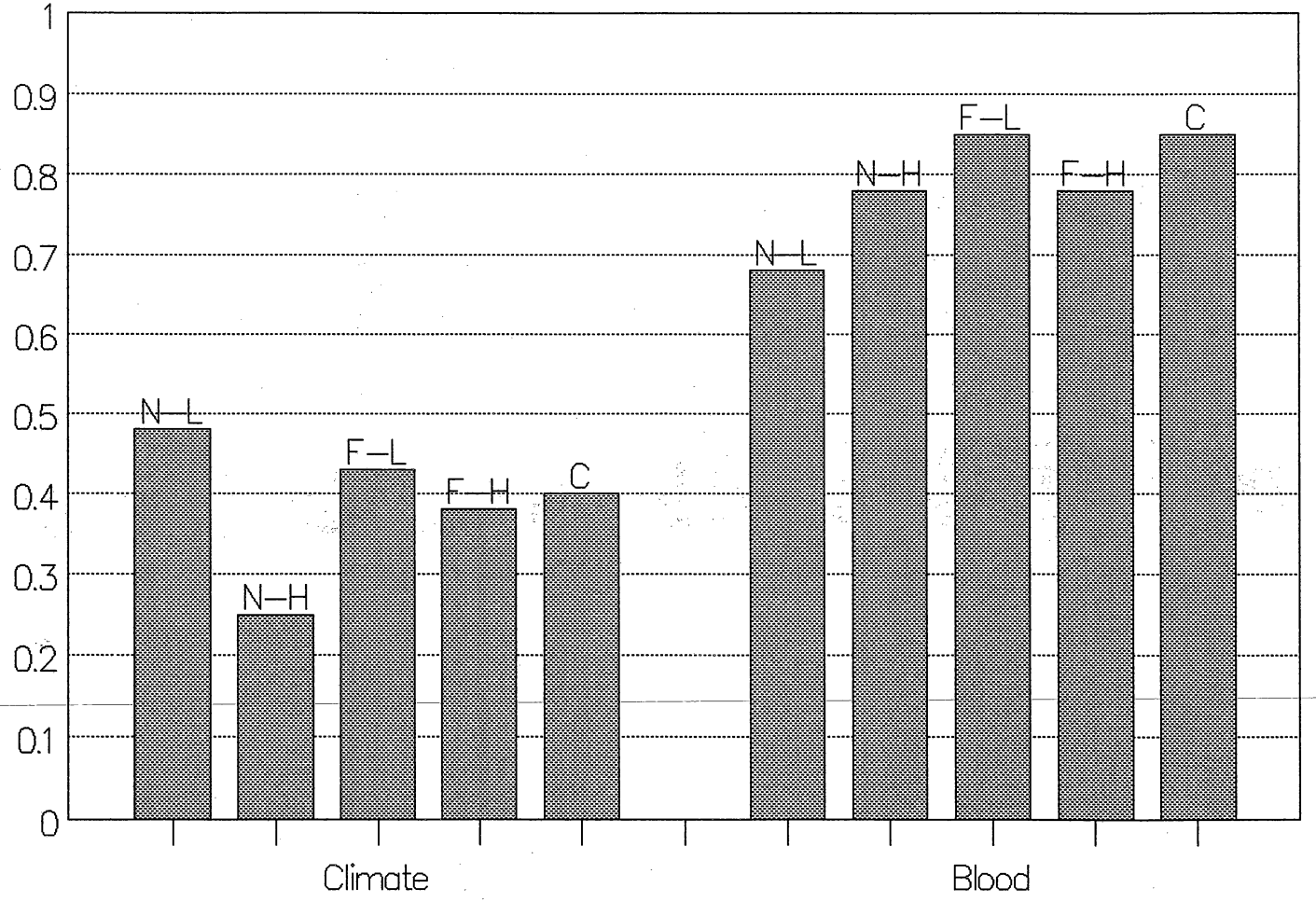
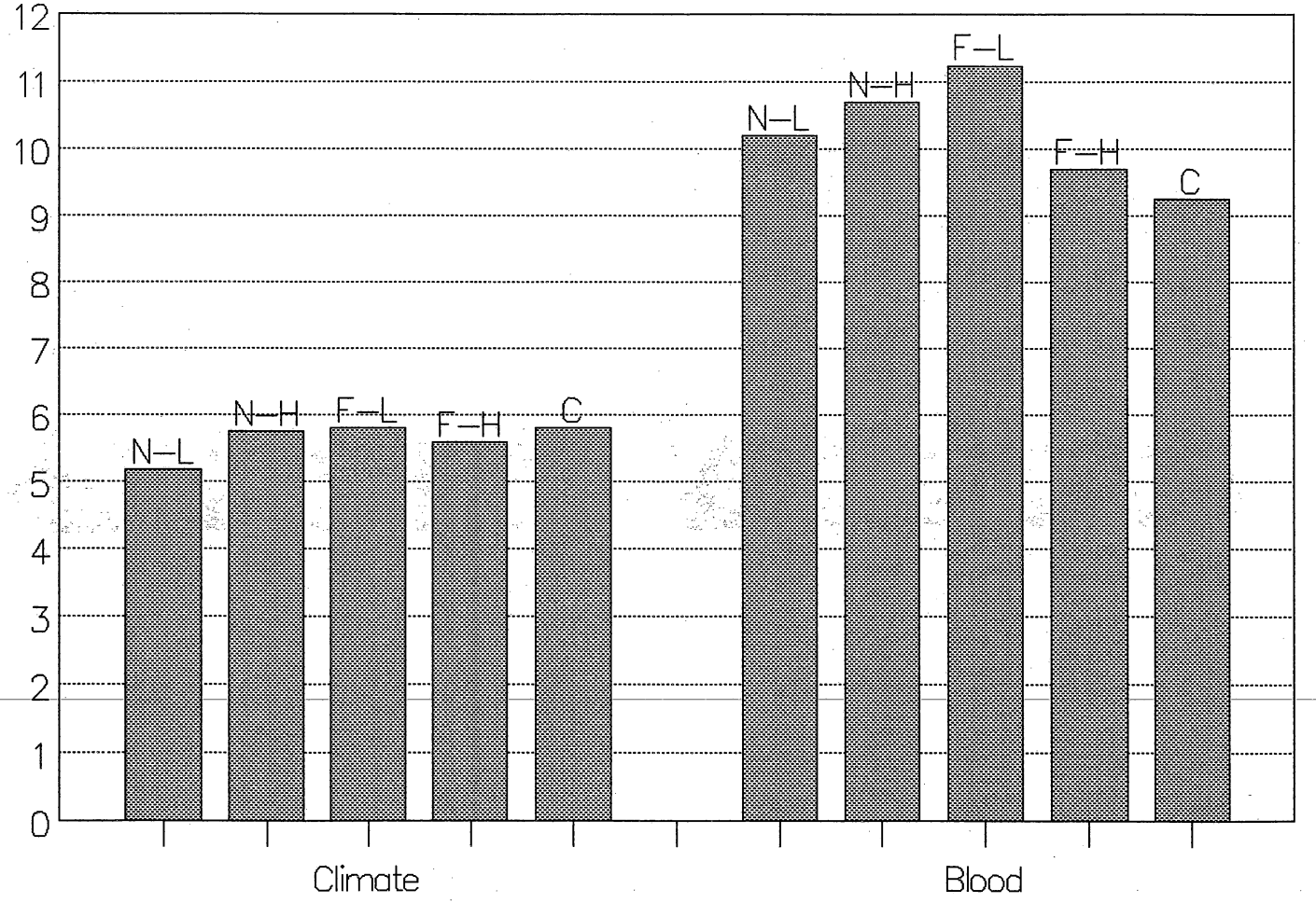


Figure 7: Means for Free Recall Scores



memorable and easier to learn. The means for climate questions correct were 3.66 and for blood 4.20, t (178) = 4.71, $p < 0.001$. The means for inferences correct for climate were 1.53 and for blood 1.71, t (178) = 2.83, $p < 0.01$. The means for solution of the new analogy were 0.38 for climate and 0.78 for blood, t (178) = 8.26, $p < 0.001$. The means for the free recall scores for climate were 5.60 and for blood 10.33, t (178) = 14.26, $p < 0.001$.

Separate analyses of variance were computed on the number of questions correct, the number of inference questions correct, the correct solution of a new analogy, and the number of facts freely recalled. Data for the passages on climate and blood were analyzed both together and separately. Data were analyzed with a 2 (near vs. far analogy) X 2 (high vs. low imagery) analysis of variance. Domain distance (near or far) was a within-subjects variable for this and all the following analyses.

The analyses of variance revealed a main effect for only the new analogy dependent measure for climate. The subjects who read the climate passage with low imagery analogies successfully solved the new analogy more often than those with high imagery analogies or with no analogy, although the difference was only marginally significant, F (1,159) = 3.862, $p = 0.051$. This effect is shown in Figure 4.

The only other significant finding for the dependent measures was an interaction between domain and imagery in both the climate and the blood passages on the inference questions correct measure. For the climate interaction, F (1,159) = 3.551, p = 0.061. For the blood interaction, F (1,159) = 6.786, p = 0.010. Figure 5 shows this relationship. For both climate and blood, the near domain, high imagery analogy (N-H) and the far domain, low imagery analogy (F-L) resulted in the highest number of inferences correct.

Table 3 shows the comparison of means for all four dependent measures collapsed over imagery and collapsed over domain distance. The means for climate inferences correct for domain distance collapsed over high and low imagery are for near analogies 1.59 and 1.53 for far analogies, and for imagery collapsed over near and far domain distance are for low imagery 1.59 and 1.53 for high imagery. This relationship between the means is similar for blood with 1.65 for near and 1.75 for far collapsed over imagery, and 1.64 for low and 1.76 for high collapsed over domain distance.

Repeated measures analyses of variance were computed on the four dependent variables, combining the results over the two passages. A significant within-subjects effect for inferences correct was found for imagery by domain distance, F (1,159) = 4.02, p = 0.047. These results confirm the

TABLE 3

Means for Domain Collapsed over High and Low Imagery and Imagery Collapsed over Near and Far Domains

	Domain Distance		Imagery		
	Near	Far	Low	High	Control
Climate					
Questions	3.74	3.64	3.75	3.63	3.55
Inferences	1.59	1.53	1.59	1.53	1.40
New Analogy	0.36	0.39	0.45	0.30	0.40
Free Recall	5.46	5.73	5.49	5.69	5.80
Blood					
Questions	4.27	4.14	4.19	4.22	4.13
Inferences	1.65	1.75	1.64	1.76	1.80
New Analogy	0.73	0.81	0.76	0.78	0.85
Free Recall	10.53	10.47	10.72	10.28	9.25

interaction between imagery and domain distance when the passages are examined separately, where the highest scores were obtained when low imagery was combined with far domain and high imagery was combined with near domain.

Table 4 presents the number of analogies spontaneously mentioned within the free recall responses. These data were analyzed with Chi Square Tests of Independence which were all nonsignificant. The number of spontaneously mentioned analogies was 92, which was reported by 67 subjects. Twenty-five subjects mentioned the analogies in both passages.

TABLE 4

No. of Times Analogies Spontaneously Mentioned

Domain Imagery	Near Low	Near High	Far Low	Far High
Climate	7	11	11	13
Blood	15	12	15	8
Combined	22	23	26	21

DISCUSSION

The experimental results obtained in this study did not support the main hypothesis, which was that analogies from far distance domains would facilitate learning and memory more than analogies from near domains. Data from the different analogies showed no significant main effects for domain distance, either near or far. Theoretically, according to Gentner (1982), far domain analogies should provide a structure for learning and remembering new knowledge more so than near domain analogies, because more mental processing is done when there is less surface similarity between two domains. Hansen (1987) and Halpern, Hansen and Riefer (in press) found far domain analogies to be superior to near domain analogies or the no analogy condition for three different passages, with significant results for five types of recall tasks.

Furthermore, high or vivid imageability was found by Halpern, Hansen and Riefer to be an important facilitator for comprehension and recall. Paivio's (1969) dual theory of memory proposes a verbal as well as a visual image which created two memory traces, thereby suggesting that analogies that are more concrete are more apt.

Why then did the subjects in this study perform almost directly contrary to expectation? Examination of the graphs for the four dependent measures demonstrates that in almost all cases, the near domain, high imagery analogy and the far domain, low imagery analogy had the highest mean scores. This is particularly striking for inferences correct, which had a significant interaction between imagery and domain distance.

Perhaps having both high imagery and far domain interferes with structure-mapping. High imageability may have influenced the amount of mapping done initially, thereby reducing the level of abstraction involved in the deeper analysis of the analogy. Riechman and Coste (1979) suggest that imagery requires a shallow level of processing. On the other hand, far domain analogies are referred to by Hofstadter (1981) as deep analogies. Far analogies may require a deeper level of processing as suggested by D. Gentner, who describes scientific analogies as being high in abstractness and clarity. For instance, the most significant results in this study were the interactions obtained on the dependent measure called "inferences correct" and the correct solution of the new analogy. Both the low imagery analogies for climate were abstract--the far domain analogy was about arguments, the near was about sonar mechanisms. Perhaps these subjects developed the schema for

these abstract analogies which facilitated solving new analogies and making correct inferences. In the case of the high imagery, far domain analogy, perhaps only the imagery made an impression at a shallow level interfering with the process of analyzing the deeper relationships, causing errors in the conception of the target domain.

The research by Gentner and Gentner (1983) and Collins and Gentner (1987) showed that analogies can produce predictable errors within the conception of a knowledge domain. The study by Gentner and Gentner (1983) involved a passage on electricity with two analogies--one was flowing waters and the other was teeming crowds. Each analogy produced a different set of inferences, one of which caused errors in the solution of problems about electricity. These consequences were examined in more detail in a study by Collins and Gentner (1987), where they analyzed the mental models constructed by two novice subjects on the topic of evaporation. Both studies maintain that the inferences and the errors people make in a topic are influenced by the analogy used or the mental model constructed.

Another possible explanation is the comprehensibility of the analogies. Tourangeau and Sternberg (1981) thought that comprehension is easier when the target domain and the base domain are more similar. Their results showed that the more dissimilar the domains are the more striking they are,

but not necessarily more comprehensible. For instance, the domains of parades and tumors are very dissimilar; and the analogy of the parade is very striking when considering the problem of removing the tumor. However, the story of the parade was most often missed as a significant analogy to the problem of the tumor. Unless the analogy was pointed out, it was not understood. Their research suggests that domain distance is not an important variable.

Although the pilot study for the present study rated the analogies on how much they helped in understanding the passage, this rating may not have accurately assessed the comprehensibility or the aptness of the analogy. In other words, the analogy could have been comprehensible itself but still not have helped in understanding the passage, or it could have been incomprehensible in terms of the deeper relational structure.

Comprehensibility was emphasized by Gentner (1982) as very important in scientific analogies. In her research, scientific analogies were rated high in base specificity. Base specificity is defined as how well the base is understood. Moreover, if the analogy is incomprehensible, it may interfere with learning and memory. The comprehension rating for Phase II of this study referred to understanding after reading the passage and the analogy. Evidently, there is still a need for a more precise rating

of the analogy separately from the passage on comprehensibility and perhaps also a rating on comprehension of the relational structure.

As for the familiarity of the analogies, this was not rated. Prior knowledge for the passage itself was rated, but not prior knowledge for the analogy. Halpern (1987) mentions the importance of the analogy in conceptualizing a problem by relating it to the familiar. Petrie (1979) emphasizes the function of analogy as a bridge between old knowledge and new. As Hansen (1987) mentioned in her discussion, it was very difficult for her to obtain good analogies. Compounding this problem in the present experiment, it was just as difficult to obtain comparable analogies all on the same topic. In the interest of having four comparable analogies for each passage, imaginary or fictional analogies were used. Gick and Holyoak (1980) propose that the optimum level of abstraction for an analogy could be determined by the highest degree of correspondence of relations between the two topics. Therefore, imaginary analogies were used keeping the correspondence of relations very high. However, an imaginary analogy cannot be a familiar one.

Gentner (1982) defines the base as familiar knowledge. In her structure-mapping theory, she proposes that relations are mapped from the base to the target--that is, from the

familiar to the unfamiliar. If the base is imaginary information, there is no possibility of structure-mapping. Therefore, the analogy cannot facilitate learning or memory; but it can possibly interfere with the building of schema or analysis of the deeper structures of the base and target domains.

On the other hand, Zeitoun (1984) and Keane (1987) point out the importance of using analogies to understand unfamiliar topics. For instance, Zeitoun reasons that analogies produce the best results with unfamiliar material, because the student has not developed a schemata for it. Hansen (1987) also mentions the point that there is a need for the material to be learned to be "highly unfamiliar or there is no need for the analogy" (p. 41). The two passages, blood and climate, were not comparable on this characteristic. Most people are familiar with blood, but few are familiar with climate. As a matter of fact, the blood passage was probably more familiar than some of the imaginary analogies. Possibly, structure-mapping was reversed. Instead of the analogy providing a familiar memory structure to map the information in the passage into, the blood cells passage provided a structure for the analogy.

This researcher also found it difficult to create a list of questions that would adequately measure a subject's

knowledge of the passage yet not be too easy or difficult. The list of questions could not be too long, or it would be impossible to solicit subjects. Yet a short list of questions made the data insensitive. The blood data especially demonstrated a ceiling effect, where the data were so close to the highest possible scores that there was a lack of differences between conditions.

Many subjects commented on how difficult the climate passage was, and how much better they liked the passage on blood cells. The difference in difficulty was demonstrated in the data with the ceiling effect on the blood data as well as the fact that so many subjects left the free recall section of the test blank. Additionally, the effect showed up on the blood data more obviously, because subjects were already familiar with the information in the passage.

Finally, this researcher tried several ways to attract highly motivated subjects. Prizes were given for the top three scores. College students were given extra credit. Still, there was evidence that many subjects were not motivated. For instance, there were several test booklets where the free recall sections were left blank. Subjects apparently did not bother with this section. Several booklets had comments written in this section, like "I found this material too boring" or "I will remember not to do any more of these tests" or "I am out of time."

Even though the results of this research were not significant, it has made apparent the interplay of domain distance and imagery. I would like to see a replication using passages that are imaginary and therefore unfamiliar and analogies that are familiar. Then, subjects could rate these analogies and an attempt could be made to keep the imagery constant but vary the domain distance.

Another possibility is to see if analogical thinking can be taught. In Gick and Holyoak's (1980) research, one of the difficulties they described was that there was considerable variability in the amount of mapping done by different subjects. Zeitoun (1984) points out that students differ in analogical reasoning ability, so that when exposed to analogies some may benefit and others may become confused. Keane (1987) describes guidelines for effective analogies and how to construct them. Perhaps these guidelines can be used or the techniques used in Holyoak's problem-solving studies. Even having practice sessions solving analogies as with Miller's Analogy Test can possibly have beneficial results.

APPENDIX A

Phase I Rating Materials

The purpose of this phase of the experiment on analogies is to rate them according to whether they are high or low imagery and whether they are near or far domain. Imagery will be judged on how easily something can be envisioned. Near domain analogies are analogies which are in the same area of science.

Three or four of these analogies will be chosen for the main experiment based on these ratings. The purpose of the main experiment is to measure the effect of high imagery versus low imagery analogies and near versus far domain analogies on memory and learning.

Please read the passages and analogies very carefully. Then consider each analogy separately as you rate them. Please try to rate each analogy independently with no carry-over from one to another.

Remember subjects that are NEAR are those in the same area of science.

Thank you for participating in this experiment and for your careful rating of these analogies.

STUDENT ID NO. _____ Sex: _____ Age: _____

Educational Level (Please circle one):
Freshman, Sophomore, Junior, Senior, Post Baccalaureate

You are about to read several passages about a variety of subjects. Before reading these passages, please rate how much you know about each of these subjects using a rating scale of 10 points with labeled beginning, middle and end points. Please circle the number that is most appropriate.

1. DNA

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

2. Electricity - Ohm's Law

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

3. Lymphatic System

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

4. Enzymes

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

5. Climate

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

6. Blood Cells

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

DNA

Deoxyribosenucleic acid or DNA is the chemical of heredity. A DNA molecule has sections called genes which are located in the chromosomes. DNA molecules are found within the chromosomes of each human cell. When a human egg is fertilized by a sperm, the first set of 46 chromosomes are formed.

The four major bases of DNA are adenine, thymine, cytosine and guanine. The genetic coding system is determined both by the arrangement of these four bases and by the peptide linkages of the amino acids within the DNA. DNA directs the building of proteins from amino acids within a cell. It can create different kinds of cells and organisms. Different combinations of amino acids are directed to form different kinds of proteins and different combinations of proteins form different kinds of cells.

There are three functions of DNA: Replication, regulation and mutation. The DNA replicates the formation of proteins; these proteins regulate the activities of cells to produce the specific characteristics of the individual and the species; and these proteins produce mutations as a result of genetic engineering, diseases or defects of the environment like carcinogens.

Rate how much you learned about DNA from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that the three functions of DNA can be compared to the three processes of a tool and die-maker. The die-maker builds and designs the new model for the finished machine, replicating it. He then makes each machine that acts as a cookie cutter and punches out the parts for a new machine acting as the regulator. Finally, some of the reproductions will be mutations due to variations in the quality of the steel used or malfunctions in the cookie cutter.

How much did this analogy help you to understand the information in the DNA passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of the tool and die-maker? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "DNA," and compare it to a tool and die-maker. How similar are DNA and a tool and die-maker? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Very Close — Very Far

Consider Analogy B:

Imagine that the three functions of DNA can be compared to the three functions of carcinogens. Imagine that they affect regular cells by causing replication of the new kinds of cells with their wild unnatural growth. The carcinogens then act as regulators in the reproduction of the new tumor cells. Finally, they also would produce mutations.

How much did this analogy help you to understand the information in the DNA passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of carcinogens? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "DNA," and compare it to carcinogens. How similar are DNA and carcinogens? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Very Close — Very Far

Consider Analogy C:

Imagine that the three functions of DNA can be compared to the three effects of conformity in society. Conformity functions as a replicating aspect and creates the same opinions and standards in new members. It also regulates behavior by setting standards for new situations. Conformity can produce mutants with extremes producing rebellion or extremes obliterating other characteristics changing the nature of the conformity and thereby the society.

How much did this analogy help you to understand the information in the DNA passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of conformity? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "DNA," and compare it to conformity. How similar are DNA and conformity? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy D:

Imagine that the three functions of DNA can be compared to the three results of laboratory experiments for producing new strains of bacteria or serums. Different strains are produced by artificially manipulating the environments and the ingredients of the various containers, thereby replicating bacteria or serums. These strains are reproduced and regulated by repeating the exact conditions of ingredients and environments. During this process, mutation can be produced.

How much did this analogy help you to understand the information in the DNA passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                              A Great
  All                                                 Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of laboratory experiments? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                           Difficult
```

Think about the topic, "DNA," and compare it to laboratory experiments. How similar are DNA and laboratory experiments? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                Very
Close                                               Far
```

Which of these analogies would be the most useful to someone who is learning about DNA? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Tool and Die-Maker
Analogy B: Carcinogens
Analogy C: Conformity
Analogy D: Laboratory Experiments

ELECTRICITY - OHM'S LAW

Electricity is a form of energy. All atoms consist of charged particles. An electron is a negatively charged particle. A proton is a positively charged particle. Each atom has one or more electrons and one or more protons. Only electrons can move freely. A flow of free electrons forms an electric current. Metals have such free electrons and make good conductors of electricity. Electric current flows from the source of creation to the point of use. The flow of electric current depends on three factors: (1) the pressure that causes the current to flow (or voltage potential), (2) the conductor, and (3) the resistance of the conductor to the flow. The relationship among these three factors--voltage, amperage and resistance--comprise Ohm's Law. As voltage potential increases, the flow of current increases. As resistance increases, the current decreases. Systems of wires called circuits transmit electricity.

Rate how much you learned about electricity and Ohm's Law from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that electric current in a wire can be compared to a garden hose connected to a faucet. If you connect the hose to a faucet and turn the water on, water molecules will travel through the hose. The amount of water molecules that flow through the hose is directly related to the water pressure and the thickness of the hose. The water pressure is similar to the voltage source in an electric circuit, the rate of water that flows is analogous to the current that flows in an electrical circuit, and the physical dimension of the hose limits the amount of water that can flow just as certain conductors of electricity offer resistance.

How much did this analogy help you to understand the information in the electricity passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of a garden hose connected to a faucet? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Electricity - Ohm's Law," and compare it to a garden hose. How similar are electricity

and a garden hose connected to a faucet? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Very Close — Very Far

Consider Analogy B:

Imagine that electricity can be compared to static electricity and operates within Ohm's Law. If you have a long stretch of wool carpeting and a person wearing leather shoes walking along dragging his feet, the static electricity will be conducted quickly and easily by touching the brass plant stand or the television set. All of these things are conductors. However, touching the lush green leaves of a plant will not produce that spark of static electricity. Green leaves are not conductors of electricity but have high resistance. If you walked up and down the wool carpet dragging your feet, holding the brass plant stand, you could produce a considerable amount of current down the plant stand.

How much did this analogy help you to understand the information in the electricity passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of carpeting, leather shoes and static electricity? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Electricity - Ohm's Law," and compare it to static electricity. How similar are electricity and static electricity? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy C:

Imagine that electricity can be compared to economic principles which can function like Ohm's Law. If you process considerable remuneration into a closed system, the trend in this system will depend on individual inhibition of consumption versus the availability of further income. If the inhibition dominates, then the trend will be absorption instead of conduction cyclicly. If further income is obviously available, then the trend will be cyclic conduction of the remuneration.

How much did this analogy help you to understand the information in the electricity passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of economic principles? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                  Moderate                Extremely
  Easy                                             Difficult
```

Think about the topic, "Electricity - Ohm's Law," and compare it to economic principles. How similar are electricity and economic principles? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                  Very
Close                                                 Far
```

Consider Analogy D:

Imagine that electricity can be compared to magnetism. In order for a great deal of conductivity to occur from the source of magnetism to an object, you must have an object composed of materials with an affinity for the source of magnetism. Along with this conductivity, the area between the source and the object must be free of impediments as well as near enough to be affected.

How much did this analogy help you to understand the information in the electricity passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                          A Great
  All                                             Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of magnetism? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Electricity - Ohm's Law," and compare it to magnetism. How similar are electricity and magnetism? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Very Close — Very Far

Which of these analogies would be the most useful to someone who is learning about electricity and Ohm's Law? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Garden Hose Connected to a Faucet
Analogy B: Static Electricity
Analogy C: Economic Principles
Analogy D: Magnetism

LYMPHATIC SYSTEM

The circulatory system of the body is composed of the vascular system and the lymphatic system. The lymphatic system returns fluid from body tissues to the blood stream. It is an open system. Between the cells of the body, there are spaces known as interstitial spaces. The spaces between the cells are somewhat imprecisely called lymphatic "vessels." The lymphatic fluid circulates in the interstitial spaces. The lymph fluid is almost identical to the fluid of the flood except that it contains no red blood

cells. Lymph is transparent and straw-colored. The lymphatic system has no pump to keep it moving forward; rather, lymph moves from one portion of the body to another by muscular contractions and also by breathing movements. Direction of flow is controlled by valves that permit only a movement of fluid toward the subclavian veins.

Rate how much you learned about the lymphatic system from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that the lymphatic system as an open system can be compared to the spaces in a sponge. If you wet a sponge, its spaces fill with water. If you squeeze it, you can force the water from one end of the sponge to the other. Between the cells of the body there are spaces similar to those in the sponge; the fluid circulating in them is the lymph. The lymphatic system has no pump; rather, lymph, like the water in a sponge, "squishes" from one portion of the body to another as muscles contract, causing pressure here and there.

How much did this analogy help you to understand the information in the lymphatic system passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of a sponge full of water? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Lymphatic System," and compare it to a sponge. How similar are the lymphatic system and a sponge full of water? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy B:

Imagine that the lymphatic system can be compared to the bile system of the liver. When large amounts of nutrients contain poisonous ingredients, as alcohol does, the liver will secret bile into the blood. Sometimes one area of the body will have a build up. The bile will collect in this area and surround the poisons and dissolve it. Then by muscular contractions in that area the bile containing the poisons will be disbursed into the blood and taken back to the liver where it is cleansed from the blood and eliminated.

How much did this analogy help you to understand the information in the lymphatic system passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of the bile system? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                  Moderate                Extremely
  Easy                                             Difficult
```

Think about the topic, "Lymphatic System," and compare it to the bile system. How similar are the lymphatic system and the bile system? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                  Very
Close                                                 Far
```

Consider Analogy C:

Imagine that the lymphatic system can be compared to the employment system. When jobs are scarce in one area of the country, people will move into areas where employment is more promising. When jobs are created in another area of the country, prospective workers will move into that area. Some will be hired. The excess will then move on to another area where prospective employment is possible. Compare the muscular contraction of the lymphatic system to the availability or non-availability of employment. Similar to the valves that do not allow the return of fluid, knowing of the lack of employment in one area keeps the trend of the unemployed moving forward to new areas of possibility.

How much did this analogy help you to understand the information in the lymphatic system passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                              A Great
  All                                                 Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of the employment system? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                            Difficult
```

Think about the topic, "Lymphatic System," and compare it to the employment system. How similar are the lymphatic system and the employment system? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                 Very
Close                                                Far
```

Consider Analogy D:

Imagine that the lymphatic system can be compared to the system of interstitial fluid in the brain. When the interstitial spaces in the brain contain too much liquid, slight pulsations occur which transfers the liquid into other regions or into the circulatory system. Similarly it uses an open system between the cells. This is done without a central pulsatile.

How much did this analogy help you to understand the information in the lymphatic system passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of the system of interstitial fluid of the brain? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Lymphatic System," and compare it to the system of interstitial fluid in the brain. How similar are the lymphatic system and the system of interstitial fluid in the brain? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Very Close — Very Far

Which of these analogies would be the most useful to someone who is learning about the Lymphatic System? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Sponge
Analogy B: Bile System of the Liver
Analogy C: Employment System
Analogy D: System of Interstitial Fluid of the Brain

ENZYMES

Enzymes are indispensable to life. They facilitate chemical reactions but are not themselves affected in the process. They are catalysts. An enzyme is a giant molecule which provides a surface on which other molecules can come

together and react with each other. They facilitate growth, maintenance and change in living creatures. Enzymes are specific in that they usually catalyze only a single chemical reaction. The chemical with which the enzyme reacts is termed its substrate. The enzyme-substrate combination forms a complex molecular structure in which chemical reactions take place. The enzyme, which remains unchanged, then separates from the product of the reaction. Many enzymes break down complex substances into simpler ones by hydrolysis. Other enzymes build complex compounds from simple ones by synthesis.

Rate how much you learned about enzymes from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9

Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that enzymes can be compared to the ministers and judges who respectively make and dissolve human matrimonial bonds. The minister performs the marriage ceremony and the couple leaves with a new bond between them. The minister is only momentarily involved and remains unchanged and available to perform other ceremonies. In a divorce court, a judge performs the dissolution, and the couple leaves as two separate individuals as the judge moves

on to perform other divorces. The minister represents those enzymes which synthesize, and the judge represents those enzymes which hydrolyze.

How much did this analogy help you to understand the information in the enzymes passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of ministers and judges? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Enzymes," and compare it to ministers and judges. How similar are enzymes and ministers and judges who marry and divorce people? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy B:

Imagine that enzymes can be compared to adrenal hormones. Adrenal hormones in the large intestine can help your dinner's waste materials such as the husks of corn kernels to combine with more easily eliminated wastes. These hormones are not changed and move on to assist other pieces to join. Different adrenal hormones help to further

break down foods such as beef steak so that their food values are more easily absorbed. These hormones also are not changed and can move on to break down other pieces of undigested food.

How much did this analogy help you to understand the information in the enzymes passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of adrenal hormones in the large intestine? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Enzymes," and compare it to adrenal hormones. How similar are enzymes and adrenal hormones in the large intestine? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy C:

Imagine that enzymes can be compared to ideas. Creative ideas when added to other thoughts bind all together into a new synthesis. Yet these creative ideas still can stand alone and further inspire other thinkers. Analytical ideas break thoughts down into more basic units.

Even so, these analytical ideas also can be used in other areas to analyze theories.

How much did this analogy help you to understand the information in the enzymes passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of creative or analytical ideas? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Enzymes," and compare it to ideas. How similar are enzymes and creative or analytical ideas? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy D:

Imagine that enzymes can be compared to digestive chemicals that combine or dissolve bonds between molecules of food. When digestive chemicals are combined with nutritional and oxygenated molecules, they provide a unifying surface so these molecules can synthesize into one substance. These digestive chemicals are not altered by this process and can go on to other syntheses. Some of these chemicals react with several different molecules which

can then separate and be utilized by the digestive system as fuel. These digestive chemicals also are not consumed in the process but can move on to further hydrolysis.

How much did this analogy help you to understand the information in the enzymes passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                                A Great
  All                                                   Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of digestive chemicals? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                           Difficult
```

Think about the topic, "Enzymes," and compare it to digestive chemicals. How similar are enzymes and digestive chemicals? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                  Very
Close                                                  Far
```

Which of these analogies would be the most useful to someone who is learning about enzymes? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Ministers Who Marry and Judges Who Divorce
Analogy B: Adrenal Hormones in the Large Intestine
Analogy C: Creative and Analytical Ideas
Analogy D: Digestive Chemicals

CLIMATE

Radiant energy from the sun travels to the earth by electromagnetic waves. About 26 percent of this solar radiation, or insolation, is reflected by clouds, gases and suspended particles in the atmosphere and is returned into space. Insolation is defined as the amount of solar radiation received per unit of horizontal surface. The insolation which is converted to the heat and kinetic energy that create weather and climate. The amount of solar energy that reaches the Earth's surface varies with latitude. The latitudes where the Earth receives the Sun's most direct rays affects how much of the energy is absorbed. If the angle is sufficiently oblique, the electromagnetic waves will skid off, and the energy will be dissipated. This is what occurs in the area known as the Tundra. It is so far north that even in the summer the angle has too much slant to absorb the radiant energy resulting in a cold climate.

Rate how much you learned about climate from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that radiant energy can be compared to skipping stones across a pond. The angle that the stone strikes the

surface of the water affects how many times the stone will skip or how soon it will sink. In order to sink a stone, you must throw the stone straight down into the pond, otherwise it bounces along the surface. In order to skip the stone across the surface of the pond, you must throw the stone on an oblique angle. In the case of the Sun's radiant energy this would spread the energy over a larger surface resulting in less warmth absorbed.

How much did this analogy help you to understand the information in the climate passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of a stone skipping across the surface of a pond or sinking into the pond? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Climate," and compare it to skipping a stone across a pond. How similar are climates and skipping stones across a pond? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy B:

Imagine that radiant energy can be compared to infra red lamps used to keep food warm in a cafeteria. The heat rays of the lamps are directed straight down on the food so that the heat is absorbed by the food. If the light from the lamps were directed toward the food on a more oblique angle, much of the heat would be lost as it skidded off the food.

How much did this analogy help you to understand the information in the climate passage? Circle the number that applies.

0	1	2	3	4	5	6	7	8	9
Not At All									A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of an infra red lamp over food in a cafeteria? Circle the number that applies.

0	1	2	3	4	5	6	7	8	9
Extremely Easy				Moderate				Extremely Difficult	

Think about the topic, "Climate," and compare it to an infra red lamp over food in a cafeteria. How similar are climates and infra red lamps over food? In other words, how closely related are they?

0	1	2	3	4	5	6	7	8	9
Very Close									Very Far

Consider Analogy C:

Imagine that radiant energy can be compared to philosophical arguments. Arguments that are directed to the point are more completely absorbed and convincing. Therefore, if the argument is completely to the point, the chances of successfully convincing a subject are much greater. If the arguments are directed obliquely around the point, chances of a successful conversion are much less due to the dispersal of the power.

How much did this analogy help you to understand the information in the climate passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of philosophical arguments? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Climate," and compare it to philosophical arguments. How similar are climates and philosophical arguments? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy D:

Imagine that radiant energy can be compared to sonar mechanisms. The surfaces that receive direct signals from a sonar mechanism will reflect these signals directly or absorb them completely. If the sonar device sends various sounds directly, the sounds are reflected more directly. If the sonar device sends these various sounds out obliquely, the results will be less distinctive. The sounds will be spread over a larger surface resulting in greater disparity of vibrations and absorptions.

How much did this analogy help you to understand the information in the climate passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                              A Great
  All                                                 Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of sonar mechanisms? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                           Difficult
```

Think about the topic, "Climate," and compare it to sonar mechanisms. How similar are climates and sonar mechanisms? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                Very
Close                                               Far
```

Which of these analogies would be the most useful to someone who is learning about climate? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Skipping Stones Across a Pond
Analogy B: Infra Red Lamps in a Cafeteria
Analogy C: Philosophical Arguments
Analogy D: Sonar Mechanisms

BLOOD CELLS

There are three kinds of blood cells: Red cells called erythrocytes, white cells called leukocytes, and platelets called thrombocytes. The red blood cells carry oxygen and food to the cells of the body. They are small and disk-shaped cells without nuclei. They are manufactured in the red bone marrow continuously and comprise about 44 to 48 percent of the total blood volume. The white blood cells are larger and have a nucleus. Their function is to defend against infection. There is a wide variation in the proportion of white blood cells between people and even in the same person at different times. Platelets are blood cells that have colorless, anuclear bodies that form chemicals that combine with other chemicals in the plasma to form a network of fibers that form a blood clot. They are a result of the fragmentation of certain large cells in the red bone marrow.

Rate how much you learned about blood cells from this passage. Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Almost Nothing — A Great Deal

Consider Analogy A:

Imagine that red blood cells can be compared to red knights who supply food and weapons to various parts of the castle. Forty-four to 48 percent of all knights are red knights. The white knights are the white blood cells who fight the black knights or bacteria who are trying to invade the castle. The number of white knights varies tremendously within and between castles. The bricklayers are platelets who repair the holes made in the castle during the invasion.

How much did this analogy help you to understand the information in the blood cells passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of red knights, white knight, and bricklayers? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely Easy — Moderate — Extremely Difficult

Think about the topic, "Blood Cells," and compare it to knights. How similar are blood cells and knights? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                  Very
Close                                                  Far
```

Consider Analogy B:

Imagine that blood cells could be compared to tree sap. Imagine that there are three types of cells in tree sap. Red sap cells carry oxygen and food to all the cells of the tree. Forty-four to 48 percent of all tree sap is red sap. White sap cells defend against invasion by insects. There is wide variation in the percentage of sap that is white sap within a tree at any one time and from tree to tree. Colorless fiber sap forms clots to plug any holes that may occur in the tree's structure.

How much did this analogy help you to understand the information in the blood cells passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                              A Great
  All                                                 Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of tree sap with red sap cells, white sap cells and fiber sap cells? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely              Moderate                Extremely
  Easy                                         Difficult
```

Think about the topic, "Blood Cells," and compare it to tree sap. How similar are blood cells and tree sap cells? In other words, how closely related are they?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Close — Very Far

Consider Analogy C:

Imagine that blood cells could be compared to judicial principles. Imagine that there are three kinds of judicial principles--truth, liberty and the pursuit of happiness. The principle of truth nourishes the system and keeps it alive. Truth could comprise about 44 to 48 percent of the system leaving room for individual freedom and happiness. Liberty gives the system power to protect itself from detrimental factors that might destroy the system. The percentage of liberty within a system and between systems varies to a great degree. The pursuit of happiness principles repairs any damage to the system and between systems varies to a great degree. The pursuit of happiness principle repairs any damage to the system by keeping morale high.

How much did this analogy help you to understand the information in the blood cells passage? Circle the number that applies.

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — A Great Deal

Try to form an image of this analogy. How easy or difficult was it to form an image of the judicial principles of truth, liberty, and the pursuit of happiness? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                           Difficult
```

Think about the topic, "Blood Cells," and compare it to judicial principles. How similar are blood cells and the judicial principles of truth, liberty, and the pursuit of happiness? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                  Very
Close                                                 Far
```

Consider Analogy D:

Imagine that blood cells can be compared to three chemical processes in the brain. Imagine that the first process, involving amino acids, provides nutrition and oxygen to various parts of the brain. About 44 to 48 percent of chemical processes that go on in the brain involve amino acids. The second process, involving lymphatic substances, protects the system from encroachment by harmful factors. The percentage of chemical processes that involve lymphatic substances varies tremendously from time to time and between different brains. The third process, using complex proteins, restructures penetrations into the brain.

How much did this analogy help you to understand the information in the blood cells passage? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At                                              A Great
  All                                                 Deal
```

Try to form an image of this analogy. How easy or difficult was it to form an image of chemical processes of the brain involving amino acids, lymphatic substances, and complex proteins? Circle the number that applies.

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Extremely                Moderate                Extremely
  Easy                                           Difficult
```

Think about the topic, "Blood Cells," and compare it to chemical processes of the brain. How similar are blood cells and the chemical processes of the brain involving amino acids, lymphatic substances, and complex proteins? In other words, how closely related are they?

```
  0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very                                                Very
Close                                               Far
```

Which of these analogies would be the most useful to someone who is learning about blood cells? Which would be the next most useful, etc. Please rank these four analogies according to their relative usefulness.

Analogy A: Red Knights, White Knights and Bricklayers
Analogy B: Red, White and Fiber Tree Sap Cells
Analogy C: Judicial Principles of Truth, Liberty and the Pursuit of Happiness
Analogy D: Chemical Processes of the Brain--Amino Acids, Lymphatic Substances, and Complex Proteins

APPENDIX B

Climate Passage and Analogies

Radiant energy from the sun travels to the earth by electromagnetic waves. About 26 percent of this solar radiation, or insolation, is reflected by clouds, gases and suspended particles in the atmosphere and is returned into space. Insolation is defined as the amount of solar radiation received per unit of horizontal surface. The atmosphere and the earth's surface absorb about 70 percent of insolation which is converted to the heat and kinetic energy that create weather and climate.

The amount of solar energy that reaches the earth's surface varies with latitude. The latitudes where the earth receives the sun's most direct rays are warmer. The angle that the sun's rays strike the earth affects how much of the energy is absorbed. If the angle is sufficiently oblique, the electromagnetic waves will skid off, and the energy will be dissipated. This is what occurs in the area known as the Tundra. It is so far north that even in the summer the angle has too much slant to absorb much of the radiant energy resulting in a cold climate.

Far Domain, High Imagery Analogy

Imagine that radiant energy can be compared to skipping stones across a pond. The angle that the stone strikes the surface of the water affects how many times the stone will skip or how soon it will sink. In order to sink a stone, you must throw the stone straight down into the pond. In order to skip the stone across the surface of the pond, you must throw the stone on an oblique angle. In the case of the sun's radiant energy, this would spread the energy over a larger surface resulting in less warmth absorbed.

Near Domain, High Imagery Analogy

Imagine that radiant energy can be compared to infrared lamps used to keep food warm in a cafeteria. The heat rays of the lamps are directed straight down on the food so that the heat is more efficiently absorbed by the food. If the light were directed toward the food on a more oblique angle, much of the heat would be lost as it was reflected off the food. For instance, the food on the edges of the lamps is not as warm as that in the center.

Far Domain, Low Imagery Analogy

Imagine that radiant energy can be compared to philosophical arguments. Arguments that are directed to the point are more completely absorbed and convincing. Therefore, if the argument is completely to the point, the

chances of successfully convincing a subject are much greater. If the arguments are directed obliquely around the point, chances of a successful conversion are much less due to the dispersal of the power.

Near Domain, Low Imagery Analogy

Imagine that radiant energy can be compared to sonar mechanisms. The surfaces that receive direct signals from a sonar mechanism will reflect these signals directly or absorb them completely. If the sonar device sends various sounds directly, the sounds are reflected more directly. If the sonar device sends these various sounds out obliquely, the results will be less distinctive. The sounds will be spread over a larger surface resulting in greater disparity of vibrations and absorptions.

APPENDIX C

Blood Passage and Analogies

There are three kinds of blood cells: Red cells, white cells, and platelets. The red blood cells carry oxygen and food to the cells of the body. Red blood cells are small and disk-shaped cells without nuclei. They are manufactured in the red bone marrow continuously and comprise about 44 to 48 percent of the total blood volume. The white blood cells are larger and have a nucleus. Their function is to defend against infection. There is a wide variation in the proportion of white blood cells between people and even in the same person at different times. When an infection attacks the cells of the body, the white blood cell count is elevated to counter the attack and defend the cells of the body. Platelets are blood cells that have colorless, anuclear bodies. They are produced as a result of the fragmentation of certain large cells in the red bone marrow. Platelets form chemicals that combine with other chemicals in the plasma to form a network of fibers that form a blood clot and are involved in coagulation of the blood.

Far Domain, High Imagery Analogy

Imagine that red blood cells can be compared to red knights who supply food and weapons to various parts of the castle. Forty-four to 48 percent of all knights are red knights. The white knights are the white blood cells who fight the black knights or bacteria who are trying to invade the castle. The number of white knights varies tremendously within and between castles. The bricklayers are platelets who repair the holes made in the castle during the attempted invasion by the black knights.

Near Domain, High Imagery Analogy

Imagine that blood cells could be compared to tree sap. Imagine that there are three types of cells in tree sap. Red sap cells carry oxygen and food to all the cells of the tree. Forty-four to 48 percent of all tree sap is red sap. White sap cells defend against invasion by insects. There is wide variation in the percentage of sap that is white sap within a tree at any one time and from tree to tree. Colorless fiber sap forms clots to plug any holes that may occur in the tree's structure due to attack by insects or other enemies of the tree.

Far Domain, Low Imagery Analogy

Imagine that blood cells could be compared to judicial principles. Imagine that there are three kinds of judicial

principles--truth, liberty and the pursuit of happiness. The principles of truth nourishes the system and keeps it alive. Truth could comprise about 44 to 48 percent of the system leaving room for individual freedom and happiness. Liberty gives the system power to protect itself from detrimental factors that might destroy the system. The percentage of liberty within a system and between systems varies to a great degree. The pursuit of happiness principle repairs any damage to the system by keeping morale high.

Near Domain, Low Imagery Analogy

Imagine that blood cells can be compared to three chemical processes in the brain. Imagine that the first process, involving amino acids, provides nutrition and oxygen to the various parts of the brain. About 44 to 48 percent of chemical processes that go on in the brain involve amino acids. The second process, involving lymphatic substances, protects the system from encroachment by harmful factors. The percentage of chemical processes that involve lymphatic substances varies tremendously from time to time and between different brains. The third process, using complex proteins, restructures penetrations into the brain.

APPENDIX D

Test Instructions and Response Sheets

This booklet contains two written passages, each of which covers a different topic. Following each passage are questions to answer about the material you have read, or problems to solve. All booklets are not the same.

After you finish reading each passage, please turn to the next page and answer the questions there without looking back at the written text. As you finish each page, please turn it and fold it under, and do not look back.

Twenty minutes will be allotted for you to complete this task. If you finish before time is called, please turn this booklet over and set it on the edge of your desk.

Before beginning, please fill in the information in the following blanks. Thank you for participating in this study. I hope that you will find the material interesting and informative.

****

Gender: Male _____ Female _____ Age: _____

Educational Level (please circle one):

Freshman Sophomore Junior Senior Post Baccalaureate

****

Instructions: Circle the point on the rating scale that corresponds most closely to your reaction to the following questions.

Prior Knowledge

(1) How much did you know about the topic before reading the passage?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
No Prior Knowledge — Moderate Knowledge — Professional-Level Knowledge

Comprehension

(2) How well do you feel you understand the material now?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Not At All — Moderately — Very Well

Amount Learned

(3) How much do you feel you learned from the passage?

0 --- 1 --- 2 --- 3 --- 4 --- 5 --- 6 --- 7 --- 8 --- 9
Very Little — Moderate — A Great Deal

Climate Questions

1. What is the definition of insolation?
   a. The layer of material under the roof that keeps the cold out in the winter and the heat out in the summer.
   b. The amount of solar heat that is reflected back into the air.
   c. Solar energy that is absorbed in the Tundra.
   d. The amount of solar radiation received per unit of horizontal surface.

2. What affects how much radiant energy is absorbed by the earth?

3. What percentage of the radiant energy is absorbed by the atmosphere and the earth's surface? (a) 50% (b) 70% (c) 26% (d) 10%.

4. What happens to radiant energy when it hits clouds and other particles in the air?

5. Why are the latitudes that receive the most direct rays of radiant energy warmer than other latitudes?

Climate Inference Questions

Based on the information in this passage, why is it warmer in the summer and colder in the winter?

Suppose scientists could devise a lens so that the sun's radiation struck the Tundra at a 90 degree angle. How would this invention affect the weather in the Tundra?

Climate New Analogy

Insolation : latitude :: headlights : (1) reflection, (2) brightness, (3) tail lights, or (4) horizon.

Climate Free Recall

Please list as many facts as you can remember about the passage you read on "Climate."

Blood Questions

1. What is the function of red blood cells?

2. How are blood clots formed?
   a. White blood cells collect at a wound and harden.
   b. Platelets form chemicals that combine with other chemicals in the plasma to form a network of fibers.
   c. Red blood cells combine with chemicals in the plasma so that they acquire nuclei and therefore are able to coagulate.
   d. All three kinds of blood cells combine at the wound.

3. What is the function of white blood cells?

4. Which two of the three kinds of blood cells originate in the red bone marrow?

5. The number of white blood cells
   a. varies not only between people but in the same person at different times.
   b. remains at 45 percent of the total number of blood cells.
   c. varies in proportion only within the same person depending on whether they are healthy or infected.
   d. varies between people depending on their size.

Blood Inference Questions

People who are anemic have starving cells in their bodies. Which kind of blood cell deficiency would they have?

Hemophiliacs are known as bleeders and have problems with clotting, which of the three kinds of blood cells would they need?

Blood New Analogy

Plug : leaking :: platelets : (1) infection, (2) nutrition, (3) bleeding, or (4) fibers.

Blood Free Recall

Please list as many facts as you can remember about the passage you read on "Blood."

APPENDIX E

Means and Standard Deviations of Subjects' Self-Assessments

Domain Imagery		Near Low	Near High	Far Low	Far High	Control
Climate						
Prior Know	$\bar{X}$	2.40	3.00	2.85	2.35	2.80
	SD	1.75	1.99	1.93	2.28	1.70
Comprehen	$\bar{X}$	4.30	5.05	4.48	4.35	4.65
	SD	2.24	1.81	1.95	2.27	2.39
Amt Learn	$\bar{X}$	3.98	4.35	3.98	3.95	4.15
	SD	2.13	2.34	1.90	2.00	2.13
Blood						
Prior Know	$\bar{X}$	3.95	3.68	3.98	4.00	3.70
	SD	1.81	2.12	1.91	2.20	1.59
Comprehen	$\bar{X}$	5.80	5.70	5.65	5.65	5.60
	SD	1.70	2.02	1.98	2.07	1.85
Amt Learn	$\bar{X}$	5.18	5.00	4.60	5.20	4.80
	SD	1.99	2.28	2.07	2.20	1.96

Means and Standard Deviations of Subjects' Self-Assessments (Continued)

Domain Imagery		Near Low	Near High	Far Low	Far High	Control
Combined						
Prior Know	$\bar{X}$	3.18	3.34	3.41	3.18	3.25
	SD	1.94	2.07	2.02	2.37	1.69
Comprehen	$\bar{X}$	5.05	5.38	5.06	5.00	5.05
	SD	2.12	1.93	2.04	2.26	2.16
Amt Learn	$\bar{X}$	4.58	4.68	4.29	4.58	4.48
	SD	2.13	2.32	2.00	2.18	2.05

APPENDIX F

Means for Correct Responses on Dependent Measures

Domain Imagery		Near Low	Near High	Far Low	Far High	Control
Climate						
Questions	$\bar{X}$	3.80	3.68	3.70	3.51	3.55
	SD	1.19	1.25	1.23	1.43	1.43
Inferences	$\bar{X}$	1.53	1.65	1.65	1.38	1.40
	SD	0.68	0.53	0.58	0.74	0.75
New Analogy	$\bar{X}$	0.48	0.25	0.43	0.38	0.40
	SD	0.51	0.44	0.50	0.49	0.50
Free Recall	$\bar{X}$	5.18	5.74	5.80	5.58	5.80
	SD	3.27	3.42	3.84	4.56	3.52
Blood						
Questions	$\bar{X}$	4.25	4.29	4.14	4.15	4.13
	SD	0.79	0.78	0.93	0.93	0.76
Inferences	$\bar{X}$	1.48	1.83	1.80	1.70	1.80
	SD	0.68	0.45	0.46	0.56	0.41
New Analogy	$\bar{X}$	0.68	0.78	0.85	0.78	0.85
	SD	0.47	0.42	0.36	0.42	0.37
Free Recall	$\bar{X}$	10.20	10.70	11.24	9.70	9.25
	SD	4.84	4.68	5.87	4.67	4.20

Means for Correct Responses on Dependent Measures
(Continued)

Domain Imagery		Near Low	Near High	Far Low	Far High	Control
Combined						
Questions	$\bar{X}$	4.05	3.96	3.86	3.93	3.83
	SD	0.99	1.12	1.23	1.11	1.17
Inferences	$\bar{X}$	1.51	1.73	1.62	1.63	1.60
	SD	0.66	0.53	0.60	0.60	0.63
New Analogy	$\bar{X}$	0.51	0.58	0.64	0.56	0.63
	SD	0.50	0.50	0.48	0.50	0.49
Free Recall	$\bar{X}$	7.74	8.24	8.26	7.93	7.53
	SD	4.89	4.85	5.81	4.84	4.20

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