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The Effects Of Animated Textual Instruction On Learners' Written Production Of German Modal Verb Sentences

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**The Effects Of Animated Textual Instruction On Learners'
Written Production Of German Modal Verb Sentences**

Elizabeth A. Caplan

A dissertation submitted to the Faculty of
the University of South Florida
in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Second Language Acquisition and Instructional Technology

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July 12, 2002
Tampa, Florida

Keywords: Animation, Dual Coding, German Grammar,
Computer Assisted Language Learning

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Dedication

To those who thought bilingualism was impossible to achieve past the threshold of childhood.

Acknowledgments

I am grateful to my husband for his encouragement and understanding. I thank my father for his support in all things. I thank my mother for her awesome inspiration and the unseen help she has given me. I thank my teachers and colleagues for their exciting commitment to open-minded inquiry.

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The Effects of Animated Textual Instruction on Learners' Written Production of German Modal Verb Sentences

ELIZABETH A. CAPLAN

(ABSTRACT)

This study investigated the effects of animation for a technology-assisted German grammar presentation on modal verbs. The premise was that many intangible concepts of dynamic grammar involve syntactic components that possess visuo-spatial characteristics. It was further speculated that these characteristics could be more effectively represented by animated versus static instructional presentations.

The supposition that animation would lend pedagogical advantage was supported by dual coding theory (Paivio, 1971, 1990), which posits two functionally separate representational systems, the verbal and the nonverbal, with dynamic mental imagery residing solely in the nonverbal system. The strength of dually coded information is that it is represented in both subsystems and, due to referential associations that cross between the two, is more easily retained and recalled. When verbal explanations are accompanied by illustrations depicting their content, it can provide external support for the learner's mental simulations of that content.

Under two treatment conditions, 44 university students of beginning German (GER 101) received large-screen multimedia instruction concerning the meanings and conjugated forms of German modal auxiliary verbs, and the grammatical rules which govern sentence structure. The independent variable was the type of visualization: static or animated text. The dependent variables were participants' total test scores as well as their individual scores on each of two task types: conjugation and word order. In addition, a posttest survey asked participants for their opinions of the instructional treatments.

Participants in both treatment groups achieved high scores on the posttest with no significant difference between them; however, the posttest survey showed that the groups did differ significantly in their opinions of the treatments, with those in the *animated* group reporting more positive reactions to the presentation. Detailed planning and lengthy preparation of both treatments may explain the high scores for both groups, and the elementary nature of the content may also account for the resulting ceiling effect. Animation should be studied further, especially with respect to more complex tasks, as well as in concert with other aspects of multimedia, such as interactivity, user-control, practice, and feedback.

Chapter I

Introduction

This study investigated the effects of animation for a technology assisted German grammar presentation on students' understanding of modal verbs. The premise was that many intangible concepts of dynamic grammar involve syntactic components that possess visuo-spatial characteristics. It was further speculated that these characteristics could be more effectively represented by animated versus static instructional presentations. The research hypothesis was that students would learn the foreign language grammar concepts better with animation. The value of the animation was empirically assessed in order to determine its effectiveness within the instructional design.

The rationale for using animation to depict concepts of German grammar lies in the fact that certain aspects, such as conjugation and word order rules, can be described as dynamic, because they involve changes in form or position. The supposition that animation would lend pedagogical advantage was supported by dual coding theory (Paivio, 1971, 1990), which posits two functionally separate representational systems, the verbal and the nonverbal, with dynamic mental imagery residing solely in the nonverbal system. The strength of dually coded information is that it is represented in both subsystems and, due to referential associations that cross between the two, more easily retained and recalled. When verbal explanations are accompanied by illustrations depicting their content, it can provide external support for the learner's mental simulations of that content.

The factor of efficiency is important to most of the state university systems across the United States. Publicly funded systems of higher education are standardized in terms of the length of courses that are considered comparable across universities. This means that virtually all United States public universities allot the same amount of time (14-16 weeks) in order to complete equal expectations for each comparable course, such as Beginning German I. The use of multimedia enhanced grammar instruction is an attempt to provide conceptual explanations that are understandable for individuals by incorporating a variety of perceptual learning styles. It

is also a means to render instruction consistent, replicable and, as informed by research, efficacious. Much of the research into individual aspects of multimedia enhanced instruction is aimed at discovery of effectiveness and efficiency: What can be effective within given time constraints?

In foreign language teaching, the dynamic properties of the classroom, live bodies and spirited interaction, should be exploited to facilitate conversation and communicative exchange and to promote verbal language acquisition. Time is short, and opportunities for speaking practice are few and precious. Research has shown in which conversational ability is facilitated through the negotiation of meaning, the give and take that speakers participate as they exchange concepts and try to express themselves (Gass & Varonis, 1985; Kramsch, 1983; Long & Porter, 1985; Pica, 1994; Young, 1983). Negotiation of meaning takes time; more importantly, it takes at least two. It is not something that can be expected of learners to accomplish on their own. Therefore, the classroom hour should be devoted to the type of activities that require dual or multiple learner participation and the instructor's actual presence (Savignon, 1991; VanPatten, 1991).

Other aspects of language learning are equally important, but may be served in other, more individualized, instructional settings. Grammar is one of those aspects, and the multimedia computer environment is one of those settings. The research presented here is classroom centered; it took place within a typical classroom of language learners. However, the questions investigated were part of a larger inquiry into how grammar instruction can be effectively presented in a multimedia format, which can ultimately be made available for use outside of the classroom.

Overview of Relevant Research

Explicit Vs. Implicit Grammar Instruction

Some second language acquisition (SLA) theoreticians argue persuasively for an implicit approach for inductive learning of grammar principles (Krashen, 1983, 1985; VanPatten, 1987, 1996; Williams, 1999). In a similar manner that one has acquired the rules of one's own native language, the structures of the target language may be gleaned through exposure, usage and habit, and, as the argument goes, researchers believe that retention (i.e., overall acquisition) is enhanced by this method. With an inductive approach, grammar is not explicitly explained,

instead the rules are induced through “carefully graded exposure to and practice with examples [...]” (Gollin, 1998). Researchers McCarthy and Carter agree that grammar can be learned inductively, but they refer only to the “grammar of the spoken language” (Carter & McCarthy, 1994; McCarthy & Carter, 1995).

More often than not, however, researchers argue for an explicit approach to grammar instruction (DeKeyser, 1994, 1995; Nagata, 1997; Seliger, 1975; Sheen, 1996), and they note that, although first language acquisition is primarily an inductive matter, “many of the more advanced features of a language are learned explicitly -- at school, for example -- even by native speakers” (Hall, 1998).

Grammar rules and structural principles may be induced, but the inductive process is slow and acquisition deepens only over the extension of time. On the other hand, grammar explanations delivered as class-hour content (a) take time for presentation, (b) learners’ mental imagery mechanisms vary, (c) teaching strategies needed to address the variety of learning styles are numerous, and (d) for many, the subject matter has a reputation for being dull.

Computer Based Instruction

Computer based instruction (CBI) has been shown to be above all efficient (Aust, Kelly, & Roby, 1993; Curtin & Shinall, 1984; Morse, 1999; Ramirez & Revard, 1998) and its assets address the above four perils in a most efficient way. Its greatest potential is simply its ability to pull the grammar out of the classroom, leaving the entire class time for communicative interaction (VanPatten, 1993). CBI gives grammar a new home; a home where all visitors have custom access. Custom in terms of schedule (computer instruction modules can be presented at flexible times and places through various, convenient delivery modes); custom in terms of pace (students can control the speed of instruction and the timing of practice pace) (Mattoon, 1991); custom in terms of responsive feedback (the computer can measure and manipulate the learner’s response time to facilitate increases in recognition and recall rates) (Hativa, Sarig, & Lesgold, 1985; Rieber & Parmley, 1992; Tennyson, 1985).

Grammar’s “new home” also has custom access in terms of student learning styles such as: auditory input preference (Viteli, 1989), textual/verbal preference (Leutner & Plass, 1998), learner controlled time on task (Okolo & Hayes, 1996), and visual representation or mental modeling (Justice, 1999). These are essentially the various forms of language input that are

available through the avenues of multimedia: sound, text, picture and animation. The various modalities available through multimedia can be offered sequentially, simultaneously, or the learners can make choices according to their own preferences.

Animated Grammar

A multimedia grammar presentation may be designed as if it were a theatrical production. In a theater, the spectators are manipulated as a single entity. Each enters as an individual with separate concerns and different amounts of complex thoughts occupying their minds. One reason that they come into a theater in the first place is to clear their minds and to allow new input (i.e., the story, characterizations and concepts) to enter their minds and to “occupy” their thoughts nearly exclusively.

To apply a theatrical approach to instruction speaks to the importance of attention upon retention (Gregg & Farnham, 1975; Hwang, 1999; McGallagher, 1975; Schleppegrell & Oxford, 1988; Tomlin & Villa, 1994; VanPatten, 1990; Williams, 1999). The theatrical directive always concerns the audience’s focus. Every production value (movement, dialogue, light, sound or special effect, etc.) controls the attention of the spectator. Apply this directive to the features of a multimedia grammar presentation and one gets what, at first, seems to be just a lot of “bells and whistles” or gratuitous attention grabbers.

Animation, whether it is moving text and pictures or simply interesting transitions between visual tableaux, can be an effective attention grabber, which lays the necessary foundation for learning (Gagne, 1968, 1970). While different learning styles and sensory preferences determine where and how an individual’s attention will be most attuned or attended, anyone’s attention can be "caught," directed and manipulated at least for an instant. Since time is an infinite series of single instances, a person's attention may be caught and focused, recaptured and refocused, in essence, held, for a relatively substantial period of time.

Each element of a multimedia presentation adds hours and expense to the production process, so the gratuitous use of such “extras” is prohibitive. Yet, foregoing elements necessary to enhance instruction should also be precluded. The details of a pedagogic multimedia presentation (text, graphics, sound, etc.) must be examined individually as well as in concert with each other within the targeted instructional context. In as far as possible, examination of the pedagogic value of each element should take place before resources are committed to its use in

the production. Some elements may have more instructional value in some disciplines than they do in others. Sound, for example, may be superfluous in math instruction yet crucial in music theory. Animation has been shown to have pedagogic value in math and physics instruction (Poohkay & Szabo, 1995; Rieber, 1996, 1988, 1989a, 1989b) but it could have more, less or even negative value in the context of foreign language grammar instruction.

Importance Of The Study

German Language Education

German is a highly structured language in that it has many rules that have few or no exceptions. It has an inflected system of verbs, which means that a given verb takes a different form depending on which pronoun with which it is paired. The clearest English equivalent is found with the verb “to be” (German: *sein*). Paired with the pronoun “I,” the verb takes the form “am,” but together with “he” the verb must be changed, or “conjugated” to the form “is.” In German, all verbs undergo such a change. Conjugation is one of the invariant rules of German grammar. The rules concerning placement of the verb are mutable according to prescribed circumstances. That means that verb placement rules are also invariant, but they change only in response to other rule-constrained changes in word order.

German SLA requires language learning efforts common to all foreign languages, such as vocabulary learning and development of listening comprehension skills, but it also requires a degree of mastery over the transformation rules of German sentence structure. The traditional display of grammatical information is typically static, textual explanations with examples printed on a page, to be read silently by each individual learner. Many aspects of grammar involve a process or a transformation whereby specific types of words (e.g., verbs) undergo a change, either in form or in placement within the sentence. Such a change or process can be seen as a series of steps which can be imparted clearly in silent, textual form, as textbooks do. However, the production of many grammatical transformations involves a single, unified process. A textbook presents a series of nonsequential steps that a learner, through practice, is expected to be able to merge into a smooth dynamic process. Animation can be used to present the information as a single, unified process right from the start. The merging of steps into a smooth transformation may be visually portrayed. Because it stimulates mental visualization of the

dynamic process, the effect of textual animation is expected to be significant in helping learners to perform grammatical transformations accurately.

Process taught by the treatment. The instructional treatments of the present study cover the four-step process of word order transformation triggered by the addition of a modal auxiliary or helping verb. A “modal” verb “helps” another verb by expressing its mood. Any verb can combine with a modal to express: obligation (must: *müssen*), permission (may: *dürfen*), volition (desire: *möchten*), intention (want: *wollen*), ability (can: *können*) or subjunctive obligation (should: *sollen*). The addition of a modal verb to an English sentence follows the usual rule for verb placement (after the subject), and then it causes displacement of the main verb by one place, e.g., *I go to town often* → *I must go to town often*. In a German sentence, the modal placement also follows the primary verb placement rule (second position), but the main verb is displaced out of the sentence and replaced at the very end of the clause, e.g., *Ich gehe oft in die Stadt* → *Ich muss oft in die Stadt gehen*. In both cases, English and German, the main verb reverts to its infinitive form, only the word order transformation presents a strong contrast between languages.

The steps involved in the transformation are as follows:

1. Conjugate the modal infinitive to agree with the subject or subject pronoun.
2. Finite modal verb assumes the main verb position (second place for statements, first place for questions).
3. Dependent infinitive is displaced and pushed to the final position of the clause (last place).
4. Dependent verb is restored to its original infinitive form.

Using the following sentence as an example, the four steps amount to a process of transformation: *Mein Onkel kommt nach Hamburg*. (My uncle comes to Hamburg.)

Step 1. Add conjugated form of modal verb *können* → *kann*

Step 2. Modal assumes main verb position (second) → *Mein Onkel kann...*

Step 3) Displaced dependent verb is pushed to last place and

Step 4. restored to the infinitive form → *Mein Onkel kann nach Hamburg kommen*
(My uncle can come to Hamburg).

A fifth step occurs when the verb has a separable prefix. When the infinitive stem is pushed into last place in the sentence, its position is always directly adjacent to its own prefix. Therefore, the stem is reunited with its separated prefix and becomes a single word once again.

E.g., *ankommen* = to arrive. *Mein Onkel kommt heute morgen an* → *Mein Onkel kann heute morgen ankommen* (My uncle can arrive this morning).

These steps are only superficially divided into five. They could readily be seen as a single seamless action. Each step is represented by a verb:

- 1) Conjugate 2) Position 3) Displace and Push 4) Restore 5) Reunite

This gives the procedure the characteristics of a physical process. As such, it is a process that is congruent to animated illustration. Because the transformation of sentence structure is a dynamic process, it is content that calls for graphically illustrated physical motion, or nonverbal as well as verbal encoding.

The general concept of modal verbs is not difficult for a learner with English as a native language or as a high-level L2. English also has modal verbs, and many of them are partial cognates with their German counterparts. However, there are some differences in meaning of modals between the two languages, and these differences are not often addressed in the lessons of most textbooks on the topic. In a survey of the seven leading college-level textbooks of beginning German (*Deutsch Heute*, *Deutsch Na klar*, *Deutsch Plus*, *Kontakte*, *Neue Horizonte*, *Wie Geht's*, & *Vorsprung*), the better part of all lessons on German modal verbs concerned their irregular conjugations. In all of the textbooks reviewed for this research, the topic of word order was never given more than a slight paragraph, and rarely with any mention of movement, change or transformation. None of them offered a description of a process, which could cue imagery of a transformation event, with the exception of *Wie Geht's*, which depicted motion through the use of an arrow pointing from the inflected verb toward the end of the sentence. The lack of emphasis on modal verb syntax prompts instructors either to present supplementary material, or to rely on the learner's ability to discover the word order rules inductively.

This study began with the creation of a presentation designed to supplement the textbook used (for years) by the university where the study took place. This book was one of the few to mention word order, but the explanatory text made extensive use of metalinguistic terminology.

"The modal verb is *always* the inflected verb in the sentence. The complementary infinitive

(which is the second part of the predicate) comes at the end of the sentence" (*Deutsch Heute*, 2000, p. 81). Since no existing supplementary material was found, that emphasized the word order aspect of modal verbs, a presentation was created to animate the visual samples of modal verbs in order to depict, rather than just explain, the transformational process involved in their use. The animated presentation was time-consuming and expensive to produce and to present. In addition, while the presentation was well received and student test scores seemed to reflect benefits from the instruction, it was not clear whether the animation was the beneficial feature, or merely the computer-enhanced presentation. Therefore, this study was undertaken to determine the extent to which computer animation supports learning for the word order rules of German modal verbs.

Under two treatment conditions, 44 university students of beginning German (GER 1120) received instruction concerning the meanings and conjugated forms of German modal auxiliary verbs, and the grammatical rules that govern sentence structure. Both conditions utilized large screen projections of multimedia presentations with audio and color slides (PowerPoint). The independent variable was the type of visualization: static or animated presentation of sample sentences in text form. The research questions that follow sought to measure the effects of the different instructional treatments upon participants' ability to properly rewrite German indicative sentences adding modal auxiliary verbs.

Research Questions

1. What is the effect of animation of sample sentences depicting a grammatical process, explained in a concurrent narrative (audio) presentation, on test scores measuring a language learner's ability to rewrite German indicative sentences adding modal auxiliary verbs, compared to static presentation of the same sample sentences?
2. Is the effect of animating the sample sentences different for each of the two discrete tasks (conjugation and word order) involved in the rewriting process?

To illustrate the premise of question 1, imagine the words of the sample sentences in a textbook chapter, concerning word order, coming to life and moving around in accordance with the silent, textual explanations. Does the animation of words aid significantly in understanding the morphosyntactic process? More precisely, does this "assisted understanding" result in the learner's increased production of grammatical sentence transformations involving that process?

The second question seeks to discover something about the particular tasks for which animation can facilitate learning. The dependent variables were participants' total test scores as well as their individual scores on each of two criterion measures: conjugation and word order.

The original aim of this research was to determine whether the use of animation added instructional value commensurate with its expense. Over the course of the study's design and implementation, the expense of using animation has decreased considerably, while access to technology in the classroom has become nearly common-place. It is no longer a question of whether to use animation, but rather, how to use it for specific objectives.

The consensus among media researchers is that animation may or may not promote learning, depending on how it [is] used. For these reasons the search for media effects has been called off. In its place is a search for the conditions under which various media, such as animation, affect the learning process. (Mayer & Moreno, 2002, p. 88)

Educational researchers concerned with visual display "agree that effective learning with visuo-spatial text adjuncts is not dependent on the professional appearance of visuals, but on the relation between these displays and the task demands and on learner's prior knowledge and cognitive abilities" (Schnotz, 2002). Second language learning involves various skills, and there are a variety of ways to achieve progress for a variety of learners. This research sought to determine whether animation had a measurable benefit for the specific tasks involved in German grammar transformations.

The findings should be most useful for designers of multimedia for German grammar instruction, but they may also be applied to the use of animation for multimedia grammar instruction for other foreign languages, especially when the point of grammar involves a consistent change of position or form. The key inquiry is: What happens when you put sample text in motion in order to depict grammatical dynamics?

Organization of the Study

This chapter introduces the issues underlying this research. The purpose of the study as well as the specifics of the research questions have been delineated. There follows a glossary of definitions of terms that are used in the literature review of chapter two. Chapter two presents a review of research literature relevant to this study. Three main areas are covered in this review: Theoretical background related to second language grammar instruction and technology-enhanced instruction, research into the dual coding theory of mental representation and

educational research into the use of animation in instruction. Chapter three describes the design of this research study and provides information about the participants, measures, instruments, and the procedures for data collection and analysis. Chapter four provides the results and analysis of the outcomes, and chapter five is a summary and discussion of the results. Chapter five also contains the implications of the study and recommendations for further research.

Glossary of Terms

Animation: The technique by means of which movement is given to a drawing or series of drawings. (A *cartoon* is a humorous or satirical drawing. *Animated* cartoons, such as "The Simpsons" are often called simply "cartoons" in English, with the concept of animation inherent in the term and omitted as an adjective.)

Associative structure: A within-system network of links and references. The functional connections of logogens to each other (in the verbal subsystem) or of imagens to each other (in the nonverbal subsystem). (see Dual coding)

Auditory input: Objects, events or ideas that are experienced through the aural sensory organ, the ears. Narration, music, lyrics and sound effects are all sources of auditory input.

CBI: Computer-based instruction. Distribution of instructional material using microprocessor-based resources.

CALL: Computer assisted language learning. Any aspect of language acquisition (see SLA) that takes place in a computer environment (PC, Internet, computer lab network, etc.).

Conjoint retention theory: Conjoint retention theory explains how referential connections between the verbal and non-verbal system not only maintain memory of information but also operate for both recall and reconstruction efforts.

Dual channeling: The presentation of information using more than one modality, such as audio plus visual.

Dual coding: Dual coding theory posits two functionally separate, representational systems, the verbal and the nonverbal, with dynamic mental imagery residing solely in the nonverbal system and linguistic representation occurring in the verbal system.

Imagens: Representations from which mental images are generated. Imagens correspond to natural objects, holistic parts of objects, and natural groupings of objects.

Imagery: Mental images of consciously experienced internal objects, events or ideas.

Latency: The time that elapses between a stimulus and the response to it [syn: reaction time].

Logogens: A hypothetical verbal representation that registers perceptual word information and makes a word response available when enough relevant information has accumulated.

Matching pacing: Forcing a learner's reading or viewing pace to synchronize with narrations or to control the speed of input processing.

Mental imaging: A dynamic process of generating a mental image from perceptual stimuli, such as a verbal description or an experience.

Mental model: Cognitive representation of the mental world.

Mental rehearsal: Verbal processes experienced as mental words or inner speech (silently "talking" to oneself).

Mental rotation: Mental manipulation of referent objects for spatial transformations and observations of perceptual changes including mental rotations on any plane, changes in imaged size, distortions of shape, and changes in the relative position of two or more objects.

Mental translation: Mental manipulation of a single aspect of a referent object, keeping all other aspects constant.

Mental world: Cognitive representation of the real world.

Modality: A particular sense or avenue of input (sight, sound, smell, feel and taste) [syn: channel].

Negotiation of Meaning: The give and take that speakers engage in as they exchange ideas and information.

Nonverbal symbolic subsystem: One of dual coding theory's two subsystems for representing knowledge and experience. The nonverbal system consists of imagery of objects and events. Environmental sounds, smells, tastes and the "feel" of objects and events stimulate nonverbal memories that are symbolically represented in mental imagery.

Referential availability: The probability that cues to one subsystem will be able to make associations to memories in the other subsystem, or that logogens will activate imagens and vise versa. The capacity for stimuli to simultaneously activate memories in both subsystems is a function of the availability of referential connections.

Referential connection: A between-system structural connection or “access route” that permits activation of memory in one system to trigger activity in the other representational system. An example of a simple referential connection is the tie between the image of an object and its name.

SLA: Second language acquisition. This concept incorporates foreign language learning, recall, retention, and systematic and pragmatic performance skills (listening, speaking, reading and writing).

Semantic matching: When a picture has elements that share meaning with textual elements, the elements may adhere to each other in memory, maintaining a meaningful connection between them.

Sensorimotor: Combining the functions of the sensory and motor activities; pertaining to the physical properties of sensory intake systems: vision, hearing, taste, smell and feel.

Syntax: A fundamental principle for encoding and decoding meaning through the placement and relationship of sentence elements.

Verbal symbolic subsystem: The other of dual coding theory’s two representational systems. Words, both visual (text) and auditory (lyric and narration) are represented by symbolic associations (phonemes, letters, words, sentences, writing patterns, etc.) that make up the system of verbal representation of the world.

Visual input: Objects, events or ideas that are experience through the visual sensory organ, the eyes. Text, pictures, colors, graphs, and their animated transformations are all sources of visual input.

Chapter 2

Literature Review

Introduction

This chapter presents the research literature that is relevant to the questions under study. The overarching field of the present study is German language acquisition as it is facilitated through computer-enhanced classroom instruction for principles of grammar. This review discusses views of grammar and its role in foreign language teaching approaches. Some issues of foreign language teaching are framed within the environment of computer assisted language learning (CALL). CALL has been informed by research in the field of computer based instruction (CBI), which, in turn, is framed here within the theory of mental representation called “dual coding.” The particular feature of CBI that is examined in the present study is animation and its effects on learning outcomes. This chapter, therefore, also discusses research relevant to the use of animation in educational multimedia.

Theoretical Background and Pertinent Research Findings

This study began primarily as a question of how to teach German grammar in a computer-based environment. This review begins with a discussion of the changing views of grammar and of different approaches to teaching it. Antecedent to the question of how to teach grammar is the question of whether or not it should be taught.

The Role of Grammar in Foreign Language Teaching

The issue of how to teach grammatical rules and principles within the formal class curriculum has generated quite a lot of interest in the field of foreign language education. Most researchers agree that the question is not whether grammar has a role in language learning, but rather whether the function of grammar is a peripheral component of foreign language teaching, or the primary core of the instructional curriculum. As a peripheral component, grammar forms an unanalyzed structure that the learner eventually conforms to by means of "feel", much like a

native speaker. For first language use, most people never think of the term "grammar", yet they make grammaticality judgements every time they communicate.

Arguments against grammar-centered language instruction rely heavily on evidence from first language acquisition research, reasoning that effective L2 learning should emulate L1 acquisition as far as possible. Other arguments counter that language acquisition, whether L1 or L2, with no focus on form, may likely reach only simplified registers, that are judged (at least socially) inferior, along with the speaker (Hall, 1998; Lally, 1998).

Premises of Grammar and Approaches to Teaching It

Approaches to the teaching of grammar have changed in indirect response to changing notions of what grammar is and how it is defined. Fodor, Bever, and Garrett (1974) have defined grammar as "any system which is able to specify the set of structural descriptions characteristic of the sentences of a language" (p.21). Throughout the decades of 1930-1950, the term "structuralism" was employed, pertaining to a taxonomic description of language features. The approach to teaching grammar during this time was typically called "grammar translation". It was a top-down approach that began with a body of existing language and analyzed relationships among its constituent parts.

Following the seminal work of Noam Chomsky (1957), views of grammar evolved to encompass the term "generative". Generative grammar "allows the notion of transformational derivation" (Fodor, Bever, & Garrett, 1974, p. 103) which can represent language as a sequence of transformations, from which complex sentences are derived from simpler ones. This concept inspired different approaches to teaching grammar.

As a view of grammar as a useful tool for generating future language use, transformational-generative grammar (TGG) is compatible with propositions in favor of instructed grammar in foreign language teaching. Taxonomic grammar is based on corpus statistics, where syntactic rules are derived from the evidence provided by analysis of existing utterances. Bound to corpus descriptions, structuralism provides no explanation of how people form sentences that they have never used before (Chomsky, 1957). TGG is not constrained to existing evidence. Instead, it is a view of language as boundless in the possibilities of utterances. Under TGG, the structure of language can be approached as a set of interchangeable parts, which join together in consistent, reliable patterns, and these patterns are studied more closely than the

parts themselves. Chomsky's view of language as a vast set of building blocks with a limited set of rules for putting them together into an infinite number of new utterances, allows an approach to language learning, which is consistent with the bottom-up approach to grammar instruction, termed "structuralist approach" (Ellis, 1994).

Structural vs. natural approach. The word "structuralist" is confusing here because the approach to foreign language curriculum does not rest on the structuralist view of grammar. *Structuralism* as a view of grammar leads to the *grammar translation method* of foreign language teaching in which a given corpus of target language is analyzed and translated into the learner's native language. The *structural approach* begins with the rules and features of grammar, and treats them as building blocks for creating learner-invented utterances. To the linguistic adult, grammar has power as a "device" (Chomsky, 1957) for generating novel sentences. The "natural" acquisition of a grammar device takes time and massive exemplary input, while overt explanations of grammatical principles provide at least a framework for immediate use of that device. Therefore, as an approach to curriculum, the structural approach is supported by the transformational-generative approach to grammar.

The structural approach to German L2 curriculum for college students embraces conceptual learning, especially for syntactical principles. Structuralists recognize two facts which influence this choice. The first is the time constraint; usually one academic year or roughly nine months. This is the time allotted to provide enough instruction for a solid foundation of continued language learning; yet few students take courses beyond the introductory level, so this single school-year is the boundary of foreign language education for most Americans participating in post-secondary education. "In one year of college German, an American student cannot afford to learn the language by trial and error and from context only; he has to resort to grammar if he wants to master German quickly" (Lohnes & Strothmann, 1973, p. xv). The second fact that influences the structuralist approach is the recognition that college-age students are "linguistic adults" whose first language intervenes, to a certain extent, with the natural acquisition of second language structures and principles. The structuralist argues that "once we have absorbed one linguistic code, we cannot learn a totally different code without some contrastive analytical knowledge of that new code" (p. xv). It is not that an adult's native language presents a barrier to second language learning, but that their prior knowledge of

language, in general, may present a need to reconcile new concepts about language with already known facts.

In the approach taken here, grammar is taught in order to facilitate language learning for cognitive adults. Facilitate means "to ease and speed the process of" and "cognitive adult" refers to someone who is thinking about language learning, exerting particular efforts, and making conscious decisions to acquire new linguistic abilities. This is an approach deemed superior by structuralists, who also recognize the time constraints inherent in American college-level foreign language teaching. The structuralist approach to German L2 instruction has contributed greatly to the development of curricular sequencing in German textbooks. That is, German textbooks generally sequence the grammatical structures in a like manner according to a logical hierarchy, according to the difficulty of structures and of their frequency in common usage. For example, present tense verbs are taught before past tense forms, past tense forms before reflexive verbs, reflexive before passive voice, etc. Each successive structure adds a new element (a form change, an auxiliary verb, a reflexive pronoun, etc.). Pragmatic concerns also determine subordinate schemes in the structural approach. For example, the conversational past is taught before the simple past because of its utilization in conversation, but the simple past forms of *sein* (to be), *werden* (to become), and *haben* (to have) are taught at the earliest possible time for their utility and frequency of use.

The structural approach to German L2 has been dominant throughout the last three decades in the U.S. (Lally, 1998a), although there have been efforts to move in a new direction. "Grammar and the formal learning of grammatical structures is very much considered a thing of the past" (Pienemann, 1995, p. 8). More recently, textbooks are edging toward the more popular "natural approach" in which communicative context precedes grammatical curriculum. A natural approach textbook, such as *Kontakte* (Terrell, Tschirner, & Nikolai, 2000) offers units that are based on communicative situations, rather than discrete points of grammar. Instead of a chapter about reflexive verbs, there is a chapter about health. The precedence of situational context over grammatical sequencing is actually just an illusion. The fact is that successful¹ natural approach

¹ *Kontakte* is deemed "successful" here, based on the fact that it is one of the most widely adopted textbook in college-level beginning German courses, according to an Internet survey conducted by the researcher during the years 1999-2002 (unpublished). See also the American Association of Teacher of German (AATG) electronic bulletin board thread "Kontakte".

textbooks have maintained nearly the same grammatical sequencing beneath their practical contexts. The chapter on health for instance, may concern sports and medicine, injury and illness. In order to speak of these things, it is necessary to use reflexive verbs. Injuries and ailments occur after other events, so the prior chapter may have been about professions, hobbies and activities using the past tense forms as the structural component. The concentration seems to be about communicative situations, but the underlying structure is still a matter of grammar. In the introduction to the textbook, Terrell and his colleagues (2000b) explain their approach as an outcropping of Krashen's five interrelated hypotheses, and they acknowledge his distinction between "acquired" and "learned" knowledge. Acquired knowledge is utilized unconsciously and automatically, and learned knowledge is "knowledge about language and the way it functions" (p.21). Learned knowledge is metalinguistic thought, while acquired knowledge is instinctive activity.

Krashen's hypotheses have been of monumental importance to the field of SLA, and they have had profound influence on the curriculum of foreign language teaching, but they have not been accepted without contest. The main issue has been the dichotomy of the distinction, acquired versus learned. Krashen suggests that what is learned does not become acquired, a concept difficult to prove and even more difficult to disprove. The distinction is very useful to FL educators no matter how contestable. Acquisition of L2 ability is the aim of foreign language education, whether it is achieved as result of learning or in addition to learning. Either way, learning has not been deemed detrimental to eventual acquisition.

Terrell and his co-authors (2000b) base their approach on Krashen's hypotheses, defining acquisition as "the mental linking of meaning to form [which takes] place during meaningful communication" (p. 18) Nevertheless, they also believe that the study of grammar "will facilitate [the] processing [of] input, and make it easier to posit the meaning-form connections that are the basis of acquisition" (p.18). They use a grammatical syllabus encompassed within a semantically based approach, which they call "topical-situational". This approach to grammar is consistent with form-focused instruction (FFI).

Form-focused instruction. FFI is another name for instructed grammar, but it is not to be confused with the concept of grammar translation. The goal of FFI is grammatical accuracy in communication, not expertise in grammar rules. It is a concept that acknowledges the durability of naturally acquired language ability, but it also declares considerable gains in the amount of acquisition that takes place within the (form-focused) classroom (Lyster, 1996).

Analysing a broad range of SLA research concerning FFI, Housen (2001) has drawn the following conclusions:

1. FFI has a positive and durable effect on foreign language learning when compared to exclusive communicative exposure to the language.
2. Effects are: faster learning, higher levels of proficiency, more accurate language use (but not more fluent language use).
3. Effects are mainly felt in language tasks that allow for planning and editing (formal language use, written language use), less in unplanned, oral language tasks.
4. FFI mainly affects the development of explicit knowledge (with possible indirect effect on implicit knowledge).
5. Effects are strongest with more explicit types of FFI.

(Slide 38).

Implicit vs. explicit grammar instruction. FFI has its own dichotomy concerning the way grammar is instructed. In explicit instruction, the rules governing grammatical structures are presented as formal statements, whereas implicit instruction "exposes the language learner to grammatical and lexical principles through natural language experience" (Lally, 1998b, p. 154). The central tensions of the implicit-versus-explicit controversy are whether to teach grammar and how it should be taught. The controversy has been between extremes, and according to Lally, has formed an unproductive binary construction. Lally agrees with those (Ellis, 1990; Garrett, 1986; Lyster, 1996) who feel there is a need for a "re-thinking of grammar within language teaching," but she states rather clearly that no answers will be found at either extreme position (Lally, 1998b, p.158). Only a hybrid solution, such as those suggested by Schmidt (consciousness-raising, 1990), Adair-Hauck, Donato, and Cumo (1994, whole language), LeBlanc and Lally (1998, student-mediated explicit instruction), or Van Patten (1992,

processing-instruction) will move the profession of foreign language teaching to more productive conversations and ultimately benefit students' language acquisition. All of these researchers have proposed and investigated approaches that merge form-focused instruction with a communicative context. For Lally, it is not so much that the hybrid methods will solve the issue, but rather that their middle-ground position is the necessary starting point for productive dialog.

Sharing this view, Hall (1998) sums up the two positions and then agrees with both of them. "Students who have been through communicative teaching at schools do not acquire a mastery of German grammar, which is essential for degree level studies. [However,] the object of communicative language teaching in schools is that pupils learn to communicate in the foreign language; the one-sided insistence on grammatical accuracy belongs to an outmoded form of teaching" (p.42). Lally and Hall both see the middle as fertile ground to find a solution. Hall sees that middle ground in the realm of technology. He takes advantage of the many facets of CALL to combine the explicit and implicit approaches with exploratory grammar learning for German L2 in a British university. Exploratory teaching is described as "planned inductive learning". Hall does not advocate anything resembling a return to a past time. In fact, no researchers, concerned with German pedagogy at the secondary level, describe a methodology of the past that is worth returning to, but neither are there many who seem satisfied with learners' progress under current methods. Hall writes of technology as a tool for teaching grammar, describing such applications as commercial software programs, grammar checkers, online grammar books, interactive webexercises, glossed texts and tandem learning (email and chatrooms). While computer programs and Internet websites provide extraordinary opportunities for learning German grammar, Hall remarks that such references may be "useless to learners who do not understand the grammatical terminology used in them" (p. 45), but he sees advantages in the future of CALL to help learners overcome their grammar deficits.

Computer-enhanced Grammar Instruction

The computer has been shown to be an invaluable tool to help researchers discover more about the way students approach language learning, in terms of the strategies they use most often (Hulstijn, 1993; Nagata, 1997) and of those proven to be most effective (Hill & Hannafin, 1997; Hulstijn, 2000). There has also been research involving CALL aimed at determining learners' awareness levels, of the computer or web environment itself (Hill & Hannafin, 1997) and their

metalinguistic awareness of learning strategies (Purpura, 1997). In addition, researchers Davis and Lyman-Hagar (1997) have used CALL to investigate ways of training learners in the use of those strategies determined to be most effective.

The computer is a unique tool for investigating various teaching conditions. There are four main instructional conditions—incidental, implicit, enhanced and explicit—which have often been discussed in SLA/FLE literature (Hall 1998; Mitchell & Redmond, 1993; Nagata, 1995, 1997; Robinson, 1997;). CALL researchers have not only been able to produce true versions of these conditions, but they have also been able to measure the effectiveness for various types of tasks and student learning styles (Viteli, 1989). The incidental condition, for example, assumes that the learner can pick up the salient aspects of the material incidentally, that is, without any special focus on those features. The implied condition presents the specific features to be learned but offers no explanation, assuming the learners will form their own rules and integrate them naturally into their “interlanguage” development. Interlanguage (Selinker, 1972) is the internal language that learners possess as they develop their foreign language skills. It includes all of the hypotheses of rules that learners typically hold in the course of their language acquisition. (Interlanguage therefore is never fixed, but evolves along with the learner's progress.) It has been described as a "system of implicit L2 knowledge that the learner develops and systematically amends over time" (Ellis, 1994). The implicit condition of instruction, therefore, aims to influence this system and to bring about accurate amendments.

The enhanced condition is similar to the implied in that there is no explanation, but the salient features are punctuated and stressed by various means such as color coding, italics, differing fonts or sizes, animation, etc. In the explicit condition, the pertinent information is simply stated in the instructional portion of the presentation. Most studies of CALL and teaching conditions have favored an explicit form-focused instruction coupled with training in the use of metalinguistic strategies for metalinguistic awareness (Nagata, 1997; Purpura, 1997; Robinson, 1997; Spada & Lightbown, 1990; Yang, 1995).

Recently, Chapelle (2002) has made the distinction between CALL and other uses of the computer for FLE, namely testing and SLA research. She uses the term CASLA, spelled out as *computer applications in second language acquisition*, to broadly encompass the three often

blended areas: CALL, computer-assisted language testing (CALT), and computer-assisted second language acquisition research (CASLR).

Computer-based instruction. To investigate the best practices for CALL, research must look backwards as well as forwards. A look over the shoulder of CALL research will see the broader field of CBI. Such research covers a vast diversity of disciplines and learning objectives, but, the type of CBI research most relevant to the present study is that concerning the use of multimedia for providing dual channeled input. The research in this arena investigates aspects of multimedia for their effects on cognitive processes. CBI is designed according to theoretical principles, but it has also been designed in order to test those principles. This review covers research studies that have examined the effect of multimedia in CBI as it applies to the theoretical principle of dual coding.

Dual Coding Theory: Mental Representations

Dual coding theory is perhaps the most influential philosophical foundation for this study and for the pedagogical justification for exploiting the affordances of multimedia. Formulated by cognitive psychologist, A. Paivio, dual coding theory postulates a division between two dominant cognitive processing systems, the verbal and the nonverbal. Dual coding theory addresses mental representations and “mental imaging,” a dynamic process that includes motor as well as sensory components (Paivio, 1971, 1990). Researchers supporting the theory claim that information is easier to retain in memory when it is dual coded (ChanLin & Chan, 1996; Mayer, 1992, 1997).

Paivio (1990) divides mental representations into two classes, the concrete picture-like and the abstract language-like. Photographs, drawings, maps and diagrams offer more concrete representation of knowledge elements than linguistic descriptions of those elements. “A three-dimensional colored motion picture with a sound track could be indistinguishable perceptually from real world events...[whereas verbal descriptions are] functionally abstract and rather arbitrary in their relation to the represented world” (1990, p. 17).

The most general assumption in dual coding theory is that there are two classes of phenomena handled cognitively by separate subsystems, one specialized for the representation and processing of information concerning nonverbal objects and events, the other specialized for dealing with language (Paivio, 1990, p. 53).

Paivio used a graphic representation to illustrate the elements of dual coding theory in both verbal (words) and nonverbal (pictorial) form. In figure 1, Paivio refers to the the nonverbal

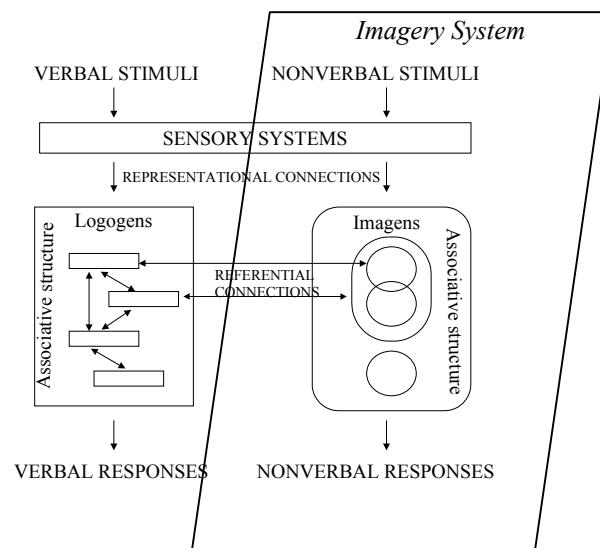


Figure 1. Mental Representations: A Dual Coding Approach (adapted from Paivio. 1990, p.67).

(symbolic) subsystem as the imagery system. He further defines imagery as “a work space in which cognitive processes can operate.” It is part of the conscious memory process, which others refer to as working memory (1990, p.74). The verbal (symbolic) subsystem also engages working memory, but in this case, the conscious is occupied with words and other linguistic elements in a sort of “mental rehearsal” of speech or writing patterns.

Paivio often uses the term “symbolic” to name both subsystems because the elements of the mind’s mental model are symbols that refer to and then invoke the imagery of knowledge and/or experience. The two symbolic systems, verbal and nonverbal, each receive input through the visual as well as the auditory sensorimotor modalities, but the input has different values within each subsystem. Visually, the verbal subsystem is activated by visual words (text, caption, annotation, etc.) and auditorally, by words as well (narration, announcement, aside, etc.) Whether auditory or visual, words are considered verbal stimuli. The nonverbal subsystem is also activated in the visual modality by visual objects (pictures, colors, animations, etc.) and in the auditory modality by environmental sounds (music, sound effects, etc.). The nonverbal symbolic system also has the added modalities of taste, smell and feel to activate memories and

stimulate recall. According to Paivio, visual objects (as opposed to text) and environmental sounds are nonverbal stimuli, or *imagens*, which lay memories (nonverbal knowledge units) in the associative structure of the nonverbal subsystem.

Logogens and imagens. *Imagens* refer to representations from which mental images are generated. *Imagens* correspond to natural objects, holistic parts of objects, and natural groupings of objects. *Logogens*, a term described by Morton (1979), are verbal representations while *imagens* represent knowledge in nonverbal form. Both can also be viewed as “cues,” because they are knowledge representations, which trigger the instance of other knowledge representations. Words activate logogens, which register perceptual word information and make a word response available which, according to dual coding theory, “accounts for word recognition” (Paivio, 1990, p. 76).

“[O]bjects or their pictures activate *imagens*, motor movements activate motor patterns, and so on” (Paivio, 1990). All stimuli are either logogens or *imagens*. Logogens operate in the verbal symbolic subsystem of mental representation. Any stimulus that triggers a memory in the verbal system is a logogen and any verbally symbolic memory activated by that logogen is a logogen, too, for it will, in turn, activate other memories. The memory activated by logogens is also referred to by Pavio as a “memory trace,” defined as “any kind of psychological record or representation of past episodic experience” (Paivio, 1990, p. 24).

Logogens that activate other logogens do so within the associative structure of the verbal system. Logogens also activate *imagens*. Words evoke imagery and experiential memories as well. A logogen activates an *imagen* in the nonverbal system by crossing a referential connection between the two systems. When new knowledge is learned, or encoded, using both representational systems, then referential connections between those systems are formed. Paivio calls these connections “referential availability” which capitalizes on “the powerful mnemonic properties of nonverbal stimuli and imagery” (Paivio, 1990, p. 253).

“The language system is peculiar in that it deals directly with linguistic input and output (in the form of speech or writing) while at the same time serving a symbolic function with respect to nonverbal objects, events, and behaviors” (Paivio, 1990, p. 53). Since language is used to describe objects, events, feelings, and other nonverbal phenomena, logogens are based upon and initially bound to *imagens* through referential connections.

A primary precept of dual coding theory is that the two systems operate separately. Although logogens are initially based on imagens – words refer to things, the verbal system can and does eventually function independently. That means that logogens often activate only more logogens and that language activities can take place entirely within the associative structure of the verbal mental world. This independence precept assumes that, in an advanced verbal symbolic system, referential connections to nonverbal representation are not automatic. This powerful referential availability is only present when nonverbal stimuli are connected with verbal cues.

To formulate interconnections between subsystems, the nonverbal system would have to be stimulated in order to produce additional mental imagery memories within the associative structure of the nonverbal system. This should be done in tandem with input to the verbal system. The aim with respect to dual coding theory is to meld experiential (nonverbal) memories with the verbal knowledge units at the time of instruction, in order to lay a network of referential connections between subsystems from which to draw upon during recall efforts.

Visual enhancement in the form of colors, fonts and animation can be used to associate words with imagens or to give “experiential memory” to text based learning. Animating written text can give a nonverbal referent to the verbal knowledge unit, thus strengthening the referential connections between the verbal and nonverbal subsystems.

One aspect of this study that sets it apart from previous animation research is that there are no graphics included in the instructional presentation, only the textual information is animated in the experimental treatment. The essential aim of animating the text is to change the verbal information into illustration. Animating the text turns it into a picture, which creates a referential connection between verbal memory and non-verbal imagery. If significant benefit is achieved through the use of animation, it may be attributed to the creation of a dually-coded memory trace and a broader web of recall connections.

The shape of the letter “E.” To illustrate his analysis of the human representational system, Paivio asks his readers to think of the letter “E.” Both auditory mention and textual representation of the letter “E” will likely evoke a mental connection to the associative structure within the verbal symbolic system. Recall of the letter “E” may activate memory nodes along the hierarchical lines of the verbal structure as the letter “E” stands ready for associative building, as

a phoneme, an orthographic agent, and in some cases (e.g., Italian), as a word. But if commanded to reverse the letter mentally to its mirror-image position, rotate it 90°, and then number the corners in counterclockwise order, the recall request would stimulate a nonverbal response and the “E” would become a referent object to be transformed within the mental imagery mechanism. In order to maintain a mental image and to track the perceptual changes of the object, now “III,” associative nodes and pathways in the nonverbal system would be activated. This object “III” could lose all referential connections to the verbal system and become a shape rather than a cipher, with new symbolic associations.

Now imagine the letter “E” embedded within a word, say, “men.” Associations activated within the verbal symbolic system form a mental representation of the letter constrained by linguistic knowledge structures, while associations within the nonverbal system form a mental image that represents a pictorial concept of “men” as a concrete object present in the real world. The mental image of the word “men” has referential connections that cross back and forth between the two symbolic subsystems. “Men” is a word and a thing. The mental imagery mechanisms stand ready to manipulate the word “men” linguistically and to manipulate the conceptual thing “men” within the nonverbal mental world. Under command to mentally rotate the word 180°, the “E” in its new position may spur new referents associated with the shape “ㄥ,” but it would also be likely to retain associative connections to verbal referents. In fact, the nonverbal imagery mechanism that helps to manipulate the object “MEN” into the object “NƎW” may form a new referential connection into the verbal structure, which stimulates activation of the logogen, “new.”

In other words, the mental manipulation of words as objects may help to form referential connections that cross back and forth between the two subsystems, forming a sturdy integrative knowledge web. Words, mentally manipulated as nonverbal images, still retain their semantic connections to the verbal symbolic system while their manipulation, movement, transformation or other nonverbal process forms an experiential memory trace accessible to the nonverbal system.

In the above example, mental transformation of the logogen/imagen “men” into “new” would also be likely to activate new associative connections (logogens or imagens) in both subsystems. The wordplay could evoke new logogens of orthographic representation even while

fresh associative connections are stimulated by the juxtaposition of the social concepts “new” and “men.”

While most associative connections, that is, paths of knowledge structures, are constrained by fixed dictum, such as laws of physics and grammatical rules, which govern those knowledge domains, the nonverbal representative systems are rule-free and unconstrained. *Die Gedanken sind frei* (thoughts are free). Mental imagery is unbounded and need not be otherwise. Research, however, has begun to show that mental imagery typically conforms to particular patterns governed by knowledge domains (Shepard, 1978). The way we think about a particular phenomenon, the imagery which represents it, may be pivotal to our eventual knowledge of it.

This does not mean that in order to really know a thing or to have expertise in a knowledge domain one must share the common imagery processes conformant to all experts in the domain. One may need to “speak this way” to be heard and to “write this way” to be understood, but it is not necessary to “imagine this way” to understand or to “think this way” to know. It does suggest, however, that the manipulation of a novice learner’s mental imagery is not automatically a constricting dictate to conform mentally, but an effort to stimulate the referential connections that typically support specific knowledge structures.

Dual Coding Theory and SLA

Paivio’s (1971) dual coding theory has inspired several empirical studies that endeavored to test his hypotheses that “the memory trace is modality-specific and that referential encoding results in a dual or multimodal trace” (p.xx). Through review of dual coding research conducted between 1971 and 1989, Paivio has found support for these hypotheses but he has amended his theory to account for an imbalance in the “mnemonic value” of the two encoding systems, “perhaps by a 2:1 ratio favoring the image code” (Paivio, 1990, p. 77). Many researchers agree that a picture is worth 10,000 words (Mayer & Gallini, 1990; Mayer & Sims, 1994; Rieber, 1997). Paivio concludes further that activation of both encoding systems “can have additive effects on recall” (Paivio, 1990, p.77). Referential connections between the two subsystems strengthen the chances of memory retrieval.

In a discussion concerning first language acquisition, Paivio postulates that the nonverbal representational system precedes development of the verbal system and that initial verbal representations refer to primarily concrete objects already represented in the nonverbal symbolic

system. This means that the verbal system is dependent upon and overlaid atop the nonverbal memory structure. An important postulate of dual coding theory, however, is that the two systems function independently. The verbal system begins as a series of referent connections leading to nonverbal representations, but it can eventually function as a separate system.

In the field of second language learning, Paivio himself, has tested his theories relative to French vocabulary learning (Paivio & Desrocher, 1979). His conclusion that “the associative learning experience requires use of imagery as well as intraverbal connections” has been reiterated by subsequent research in the SLA field.

Yoshii and Flaitz (2002) found that word annotations utilizing both text and pictures were more effective for helping adult learners retain vocabulary than either text-only or picture-only annotations. Regardless of proficiency level, the dual source annotations, available in a computer-based hypertext, helped ESL learners score higher on the three tasks of picture recognition, word recognition, and definition-supply tests, than learners who accessed only one mode, picture or text, as an annotation aid.

Ehlers-Zavala (1999) used a dual coding approach to study foreign language reading by an English as a foreign language (EFL) high school population. Given either a text-only or a text-plus-illustrations condition, 129 EFL learners then answered a comprehension questionnaire, provided free-reports and rated story segments for the strengths of imagery and affect evoked by the story during reading. Ehlers-Zavala considered the research results to support dual coding because “participants who read the story with pictures performed better than those who did not” in that they reported “a higher number of images in their free-reports and more vivid images in their story ratings” (1999). This dissertation study’s evidence that the text+picture condition offers superior results when compared with a text-only condition supports dual coding theory, and in this case, the study refers to the field of second language learning.

Studying French-speaking students’ recall (measured by translation tests) of Arabic L2 vocabulary items, Hammoud’s (1982) dissertation uses dual coding ideas to develop an associative-field technique in which students were exposed to lexical items in imagery as well as in verbal, associative contexts. This research also suggests that associative imagery facilitates vocabulary learning (as observed by translation recall tasks).

Dual Coding and Total Physical Response. While Paivio and his associates (Clark, Pressley and Desrochers) have studied dual coding theory in second language (L2) learning only for the goal of vocabulary learning, he postulates an important application of dual coding theory for L2 learning that applies to “the nonverbal-situational cognitive and behavioral contexts of all language skills including syntax” (Paivio, 1990, pp. 254-6). Paivio sees Asher’s (1969) Total Physical Response strategy (TPR) as an exemplary application of dual coding theory. In having learners act out responses to suggestions and commands, the L2 is studied in “the context of nonverbal behaviors” (Asher, 1969, 1972; Paivio, 1990). TPR elicits a motor reaction which is a concrete response to commands such as “walk,” “run,” “jump,” but assimilation into the associative structure of the verbal system requires an abstract response to the mental imagery of those verbs. The verb “run” can evoke the image of a boy running, as opposed to a horse or an engine, a stocking, a campaign, a nose, etc. Dual coding theory “leads to a strong emphasis on the role of situational contexts and imagery in second language learning. In particular, the theory suggests that language-learning strategies based on the systematic use of referent objects, pictures, activities, and mental imagery would be especially effective in promoting learning” (Paivio, 1990, p. 257).

Paivio also considered the implications of dual coding theory for acquisition of second language structural concepts. He felt “that grammar learning should be facilitated by the use of appropriate nonverbal referent situations, pictures, or imagery” and that learning strategies should be based on “the systematic use of referent objects, pictures, activities and mental imagery” (1990, p. 257).

[T]he development of grammatical skills involves formation of referential interconnections, not only between representations corresponding to objects and their names, but also between the abstract and dynamic attributes of objects (e.g., relations, transformations, actions) and their corresponding verbal descriptions (Paivio, 1990, p. 256).

Although Paivio has not, as yet, considered any aspects of technology whatsoever, the medium of instructional presentation under study here, multimedia, has properties that connect to every aspect underscored in his hypothesis: referent objects, pictures, activities, and mental imagery. Referent objects are the fundamental units of instructional design architecture. To

program events in a computer application, all elements, including text in various parcels, are treated as objects. As objects, “hunks” of text as well as “pieces” of pictures, can be made to move, change or be manipulated so that the learner may interact with them and cause them to interact with each other. The user’s activities, in this regard, prompt a sensorimotor experience that should help to form nonverbal associations. Multimedia affords learner-activated as well as automated animation of objects (hunks and pieces of text and picture). The entire multimedia module, integrating actions and objects, helps to activate mental imagery.

Animation Research

Paivio has yet to consider dual coding theory in the light of instructional technology; however, many supporters of his theory have tested the tenets in a CBI environment. Research into the cognitive effects of animation is typically based on Paivio’s theoretical precepts (ChanLin & Chan, 1996; Lai, 2000; Mayer, 1994, 1997; Mayer & Anderson, 1991, 1992; Mayer & Gallini, 1990; Mayer & Moreno, 1998; Mayer & Sims, 1994; Rieber, 1988, 1989b, 1989c, 1990, 1991, 1995, 1996, 1996b; Rieber & Hannafin, 1988; Rieber & Parmley, 1992; Schnotz & Grzondziel, 1996).

If knowledge has to be acquired about a dynamic subject matter, computer-based learning provides the possibility not only to use static, but also animated pictures. In the case of static pictures, the learner has to imagine the dynamic of the subject matter – that is, he/she has to stimulate the process internally and observe the stimulation with the “mental eye.” Animated pictures, on the contrary, can display the dynamics of a subject matter directly. (Schnotz & Grzondziel, 1996, p. 3)

Studies on the use of animation in CBI have been meager to date, and their results are spread thin across diverse disciplines and disparate designs. However, the one thing that animation studies have in common is that they all show some kind of quantitative differences due to the use of animation in instruction. Some have asserted significant benefits affecting attitudes, enjoyment, motivation and frustration levels (ChanLin & Chan, 1996; Hsieh, 1992; Poohkay & Szabo, 1995; Rieber, 1988, 1989b, 1989c, 1996; Szabo & Poohkay, 1996; Williamson, 1992; Wong, 1994), while others have tried to measure animation’s effect upon immediate recall and problem-solving skills (ChanLin & Chan, 1996; Caraballo, 1985; Childress, 1995; Hays, 1996; Lee, 1997; Lee, 1996; Mayer, 1992; Poohkay & Szabo, 1995; Towers, 1994). Delayed recall, or retention, has been the dependent variable of focus for only a few researchers (Mayer, 1992; Hays, 1996; Caraballo, 1985) and their conclusions are mixed,

with all results dependent upon additional, diverse variables such as the absence or presence of explanatory text, of synchronous or successive narration, or of spatial ability and prior knowledge. With the exception of Schnotz and Grzondziel (1996), Rieber has been the only researcher to examine the effect of animation upon latency or response times.

Rieber also measured the effect of animation across several posttest learning objectives in a mixed ANOVA design. Mayton (1991) followed Rieber's design principle with his study testing the effect of presentation strategy (*static graphic, imagery cued* and *animated*) on five different learning objectives concerning the structure and function of the human heart.

The most extensive research concerning the pedagogic effect of animation has been undertaken by Rieber (1988, 1989a, 1989b, 1989c, 1989d, 1990a, 1990b, 1991, 1995, 1996a, 1996b). Within the discipline of physics, Rieber has studied the effect of animation on students' understanding of such concepts as Newtonian laws of motion and properties of velocity. Performing nearly identical experiments with 119 4th and 5th grade children and 141 college seniors in a computer education class, Rieber attempted to "tease out the developmental differences" that might interact with the effect of animation on learning. In every experiment concerning animation, however, he also tested an additional variable that he found crucial to the learning outcome. Most Rieber studies, indeed with the exception of Packard (1994), every study that has examined the effect of animation, has used a three-condition experiment to do so. The conditions of static graphics, and animated graphics were also compared with the condition of no graphics (text only). In one case, (1988), Rieber also tested the conditions of text and no text along with the graphics treatments. His analysis techniques always involved a mixed ANOVA design because he also tested such within subject variables as learning objectives, latency, attitude, and transfer (near and far).

Rieber was not the only researcher to test the effect of animation upon attitude (Poohkay & Szabo, 1995; ChanLin & Chan, 1996; Chen, 1995; Curtin & Shinall, 1984; Lai, 2000; Rehaag & Szabo, 1995), however, he has been the only researcher, as yet, to examine the effect of practice combined with the abovementioned conditions. He tested three types of practice with adults, behavioral, cognitive and no practice, and with children, he set up a very similar experiment, but the practice was either relevant or nonrelevant to the concepts instructed, Newtonian laws of motion. He found that practice rather than animation was the effective

element. He continues to use animation in his CBI programs, but he is mindful of the appropriateness of the animation to the content. He has even viewed animation as somewhat detrimental to adults, who are able to form their own mental models of dynamic subject matter. He still believes, however, that animation can benefit children, as well as those, whose mental imagery machines are weak, i.e., little imagination (L. P. Rieber, personal communication, October 6, 1998). His last study of animation did not concern instruction, but rather, “feedback.” the reply that the computer gives to the learner in response to a right or wrong answer (1996). With regard to feedback, Rieber concluded that animated, graphical feedback can provide greater tacit knowledge than textual feedback, but he also reported that explicit understanding was not affected by visual presentation condition.

Rieber has always founded his research on Paivio’s dual coding theory in which he sees support for the use of visuals, whether static or animated (1989b). In testing the animation effect so intensively, Rieber sought to clarify the discrepancy he found between favorable reviews of the use of animation and the lack of supportive research findings. His research efforts no longer concentrate on the effect of animation in instruction, but he does continue to endorse dual coding theory and the concepts of associative and referential encoding.

As an education researcher, he supports the dual coding theory through his research findings (1990a, 1990b, 1991, 1994, 1997) and in citing the commonly held belief that the two distinct forms of input, verbal and visual, create at least two distinct ports of information retrieval, virtually doubling the chances for recall. Rieber attributes the learner’s ability to activate meaningful representational and associative processing to the dual coding aspect of combined visual/verbal input, especially with respect to feedback in computer simulation settings (Rieber, 1996).

Rieber’s studies (1988-1997) have tested the use of animation as an instructional strategy, using animation to provide immediate or “real-time” feedback to illustrate principles underlying natural phenomena, specifically Newtonian mechanics or laws of motion. Instruments developed for his research include computer programs that calculate the learner’s input and apply that input directly to the motion, position, direction, speed, etc. of an object portrayed by the computer. Rieber’s work has centered on content area from the fields of physics, math and science and the principles instructed are those that involve motion or other change of physical state.

While he supports the use of animation in multimedia presentations, Rieber has become less enthusiastic about the pedagogical value that can be attributed solely to animation in relation to other aspects of a multimedia instructional program. He credits animation with the “capability to represent information and relationships in ways that closely resemble natural phenomena” but he discredits animation’s ability to make discrete features and relationships salient. He recommends animation as enhancement to explicit instruction, yet warns of the possible reverse effect of its use in place of overt verbal explanation (Rieber, 1996, p. 7).

In their study based on dual coding theory, Schnotz and Grzondziel (1996) ask, “what is the influence of animated *pictures* on the process and the result of knowledge acquisition?” The “knowledge” under investigation was German L1 illustrated text comprehension, on the subject of the earth’s rotation relative to time phenomena. They characterize text comprehension as “a cognitive process, in which a reader transforms the presented linguistic information into a propositional representation, which in turn guides the construction of the respective mental model” (p.7).

The “propositional representation” corresponds to dual coding theory’s verbal symbolic structure and the term “mental model” refers to Palmer’s (1978) “representation of the mental world.” Like Palmer, they describe the mental model as the representation of “subject matter by analogy” and like Mayer (1994), they view a “*dynamic* mental model” as one that can be mentally played or “run” in mental simulations to represent the dynamic of the subject matter” (Schnotz & Grzondziel, 1996, p. 8).

In their analysis of mental representations, they define graphic pictures as analogies or two-dimensional external models and they postulate that “understanding a picture is a process of establishing an analogy between the picture and a corresponding mental model” (Schnotz & Grzondziel, 1996). But they claim that a static picture can only present information about the invariant structures of a phenomenon “whereas animated pictures can also display the transformation of the structures, if the subject matter is a dynamic one” (p. 8). They investigated the use of animation on text comprehension to discover if it could help the learner to construct dynamic mental models which can be “run as mental simulations.” They believe that animated pictures offer external support help to lighten the cognitive load of mental model construction but they also recognize that animated pictures provide more information to be processed by the

learner and they reflect, therefore, that the actual effects of animating pictures, in terms of cognitive demand, remain unknown (p. 10).

Under four conditions, two of which tested the effect of animated versus static, graphic pictures, 80 German university students read a 22 paragraph, illustrated, hypertextual explanation concerning the division of the earth into time zones and date zones. The other two conditions were concerned with the type of illustration, or *visualization type*, as the researchers called the variable. In one condition, the illustrations, “flat and 2-dimensional,” were called “carpet pictures” because, like a carpet, they presented the illustration of the earth as a flat scene with edges that end and begin again on the other side. A second condition presented “circle pictures,” where the earth was represented as a globe, without discernible “edges.” Each visualization type, “carpet pictures” and “circle-,” was tested in both static and animated form in a 2x2 factorial design.

A pretest instrument asked participants to explain concepts referring to time phenomena on the earth. As a learning instrument, participants were also given questions about circumnavigation and time changes as a guide to use *during* reading. Through hyperlinked architecture, students had *free access* to illustrations and to textual explanations and their frequency of access to each was automatically recorded. In this way, the researchers also studied how student look-up behaviors correspond with visualization and with graphic presentation type. They considered the frequency of participants’ access to text, a measure of learner-processing-intensity and they regarded this rate as a measure of cognitive effort.

Learners displaying more frequent access to text were held to have exhibited a greater cognitive effort than those who gathered information more frequently from pictures. The high frequency of access to text under the static, circle picture condition was taken to mean that the learners showed greater cognitive effort under this condition. This condition, using naturalistic but static pictures, was also the condition under which the lowest scores were seen for posttest accuracy.

For the natural phenomenon of the earth’s shape and movement, the carpet pictures, while less realistic, always present the earth from an equal perspective. Schnotz and Grzondziel posit that a flat view of the earth requires merely a “mental translation” in order to visualize it in different aspects, whereas a circle picture, or globular view of the earth requires “a mental

rotation,” demanding significantly greater cognitive effort – unless the picture is animated. Animated pictures reduce the cognitive load of knowledge acquisition as they provide external support for mental simulations.

The effect of animation in their experiment was to equalize the two graphic visualization forms to balance the demands for cognitive effort across the two picture-type conditions. This variable, visualization type, confounds the effect due to animation because it is clear that the results depend upon the type of illustration being animated.

For engineering design graphics, Asoodeh (1994) found that external stimuli helped students in developing the mental process essential for visualizing objects in an engineering system. Compared to the control group, who received static graphical depictions, the group that received instruction via animation reportedly performed better on a test of mental rotation.

With the redundancy of narrated text, Lai (2000) found a significant advantage for the animation of graphics to illustrate to college students the principles of computer programming languages. The researcher claimed that “dynamic representation could lead to deeper processing [and] help the learner build a runnable mental model of the system” (p. 201).

Research concerning the use of animation for instructional purposes has been conducted in the field of computer algorithms (Byrne, Catrambone, & Stasko, 1996, 1999; Hansen, Schrimpscher, & Narayanan, 1998; Kehoe & Stasko, 1996; Stasko, 1996; Stasko & Badre, 1993). These collaborative researchers generally conclude that only “small, unreliable” benefits can be attributed to the use of animation, yet they all believe that animation may still assist the instructional process of teaching computer algorithms. They believe that, whether due to faster processing (Kehoe & Stasko, 1996), or as an aid to mental model building (Byrne, Catrambone, & Stasko, 1996), or simply as an intrinsic motivator (Hansen, Schrimpscher, & Narayanan, 1998; Stasko & Badre, 1993), the particular benefits of animation should be each formally studied, especially with respect to specific tasks and to prior knowledge levels.

Animation has been used to extraordinary effect. Computer generated three dimensionally animated models of patient blood vessels have enabled doctors to make crucial decisions that were previously only possible via surgery (Marsh, 1998). Animations in computer simulations have also given dentists a “tongue’s eye view” of their patients’ bite collisions. In these cases, animation has provided essential information in a pre-coalesced form. That is, all of

the separate pieces of data gathered through scans and other measurement devices, have already been fit together to form a “big picture.” In the specific case of EAI Corporation’s program to give doctors a non-invasive way to measure the dimensions of aneurysms of the abdominal aorta, the program not only delivers an accurate three dimensional model, but it also makes a decision regarding treatment of the problem (1998).

In studying the role of animation in interpreting representations, Enyedy (1997) used think aloud protocols to see if animation helped young learners to grasp abstract mathematical relationships. The discussions of 13 pairs of middle school students, concerning the basic concepts of probability, were found to be “qualitatively” richer when CBI used animation rather than static graphic representation.

In order to support a constructivist pedagogical approach, Enyedy sees animation as a way to provide students with rich experiences with mathematical phenomena. Complementary to the constructivist ideal of self-constructed knowledge, Enyedy’s study is also founded on the dual theory of distributed cognition. Distributed cognition describes the balance of interaction and experience on the one hand with the representation of knowledge on the other. The representation of knowledge includes symbolic notation, metalanguage, graphic representation and mental modeling. Constructivism decrees that the former precedes the latter; experiential knowledge should precede representational knowledge.

Enyedy’s content area was the Probability Inquiry Environment (PIE), a process of inquiry based on a cycle of conjecture, observation and analysis. The learner's task was to judge the fairness of a game of chance. With the goal of judging, as opposed to playing, the researcher was able to frame the activity as an objective investigation and to focus students’ attention on the frequency of outcomes and away from individual end results. In effect, the game represented an event tree and a histogram at the bottom of the game screen represented the event space.

The qualitative methods employed think-aloud protocols, audio and video taping, computer recording of interactions and transcriptions including gesticular descriptions. It was this last data collection that proved the most revealing. Analysis of gestures enabled the researcher to observe where the students’ attention was focused and to code their problem solving approaches as either the *process perspective* or the *outcome perspective*. Gestures along a horizontal plane (at the bottom of the screen) could be coded as outcome perspective because

the student was pointing to the event space, while vertical gestures along the event tree indicated that the focus was on the internal nodes of the tree, and that student attention was occupied with reasoning about the process which leads to outcomes rather than with quantifying the results.

Enyedy (1997) never quantified the results of this study nor did he make any claims about the superiority of perspective or of the use of animation in teaching mathematical probability. He did however, claim that the animated condition was more conducive to a process oriented approach. The vertical movement along the event tree drew attention away from the “bottom line” of final results. “The visual grammar of the event tree supports a process interpretation that narrates the events over time and space” (p.14). Enyedy postulates that animation helps learners to “create a mental simulation of the process and ‘run’ that simulation attending to and reasoning about the intermediate events” (p.14). He also shows his preference for animation in his interpretation of Tversky (1995), with the summation that static images may successfully convey conceptual information, as they are easily interpreted as objects or concepts, but since they are not usually interpreted as actions or processes, they do not provide an equal framework with which to generate an event space for new situations. This statement can be interpreted to suggest that animation may be necessary to facilitate transfer; the use of existing knowledge in novel applications, at least in certain content areas, namely, processes, actions or changes of state, or as Rieber views it, content areas that are congruent to motion or transformation. Other animation researchers have referred to this as process *dynamics* (Mayton, 1990, 1991; Paivio, 1971, 1990; Schnotz & Grzondziel, 1996). Mayton equates knowledge of dynamic processes with “higher order concepts involving multivariate changes over time” (1990). Paivio declares mental manipulation in imagery to be a dynamic process (1971) and Schnotz and Grzondziel stipulate that animation eases cognitive load if the subject matter is a dynamic process (1996).

Substantive Issues

Functions of Animation

In a chapter of the AECT handbook of research for educational communications and technology entitled, “*Visual Message Design and Learning*,” Anglin, Towers, and Levie (2001) analyzed the role of static and dynamic illustrations. Reviewing 132 primary research studies of static and dynamic graphics as well as a number of meta-analyses of studies concerning pictures

and knowledge acquisition, the handbook states, “there is significant evidence that generally memory for pictures is better than memory for words. This consistent finding is referred to as the picture superiority effect” (p. 761).

In describing Knowlton’s (1996) semiotic approach to picture analysis, the handbook draws the distinction between digital signs and iconic signs. “Digital signs bear no resemblance to their referents” (p. 759). Words and numbers are examples of digital signs since they are arbitrary in their appearance, while pictures, maps, blueprints, charts and diagrams are “iconic signs” that must in some way resemble the thing that they represent.

All previous animation studies, save one (Speelman, 1997), have investigated the use of dynamic pictures, graphs, maps or other iconic signs that resemble the content they represent. In a review of 42 studies which included at least one animation treatment, the ACET handbook (2001) reports no study that used dynamic text as opposed to animated pictures, graphs or diagrams, nor did the review find any animation studies in fields other than science, physics, geometry, mathematics, statistics, or electronics. None of the studies of dynamic visuals reported animating the text in addition to (or instead of) the iconic display (the picture). However, Speelman’s (1997) experimental treatment presented line-at-a-time text, as compared to all-at-once textual information. The controlled presentation of visual information may be seen as equivalent to an animated condition, because it fulfills an instructional function as an attentional guide (Park & Hopkins, 1993).

In summation of the research review, the ACET handbook (2001) presents yet another conclusion that “the use of animated graphics does not facilitate learning” (p. 768); yet, because of the limited number of studies, the inconsistent functionality, relevance, and congruence of the animations tested, and due to a number of methodological flaws, “the verdict is still out on the effect of animated treatments on student learning” (p. 768). Like many researchers who study animation, the writers of the ACET handbook refuse to abandon the idea that animation is a useful and desirable tool. Therefore, they proffer directives for “future research investigating the effect of dynamic visual displays on learning” (p. 768). This study follows the directives: (a) that research should be based on a functional framework; and (b) that should instruction include “content for which external visual information is needed and which requires the illustration of motion” (p. 768). In the case of ACET’s third directive, (c) control for the effect of static

graphics, this study cannot strictly comply, since there are no graphics in use. The control is text-only because only the text is set into motion. Nevertheless, the spirit of the third directive is met, if not the letter. Visually, the two treatments are identical, with the factor of motion as the sole manipulative.

The instructional treatment under study here animated only words and incorporated no illustrations. It is only the text, or digital sign, that was animated. The words which mean “the boy eats a piece of cake” were made to move, but there was no boy or piece of cake pictured. It is only the text that was animated, in order to control focus and direct attention. Learner focus is drawn to the verb and its syntactical position, not to an image of a boy eating cake. The sentence “the boy eats a piece of cake” could very well evoke mental imagery, as well as “mind wandering” – “what kind of cake?”, “how old is the boy?”, etc. Animating the text reclaims attention and returns it to the content of syntax and away from boys and cake. Attention-getting is no small matter. It is requisite to facilitate detection and the reception of information (Sharwood-Smith, 1991). Since attention is a limited resource, it should not be squandered on extraneous information (Tomlin & Villa, 1994).

Illustration is not beneficial if it serves as a distraction. A pictorial representation of the subject of the sentence, a boy eating cake, would have a counter-productive function. It would distract attention from the content area. The sentence is only a sample, so its subject matter is not germane to the instruction, and its illustration would likely be detrimental to efficient learning. Such a picture could serve as a type of mnemonic device, but recall of the content would be circuitous at best. The memory of the image of a boy eating cake will not readily transform into the utterance “I want to eat a piece of cake,” whereas the mental image of the words, syntactically set into motion, might.

In sum, the handbook quotes Rieber's (1994) stance that “visuals are effective some of the time under some conditions” (p. 132). Therefore, there is a need to delineate the types of illustrations and their functions in order to determine what kind of picture has what kind of effect, why, how, for whom, and under what special circumstances. The use of pictures is bounded by guidelines and limitations, the primary guideline being the framework of functionality. Each picture must have a determined function.

This study incorporates no pictures, but since the words are animated, they begin to function as pictures. Therefore, consideration must be given to the functional roles they perform as if they were illustrations. Their function is the illustration of the transformative properties of German grammar, fulfilling an “explicative” role in the case of verb syntax and conjugation. An additional function is to turn the sample text into a picture.

However, what turns text to picture also imposes the guidelines for dynamic visuals. The handbook offers Rieber’s (1990) conclusions that animation may be used to assist in attention-getting, presentation or in practice opportunities. Other guidelines offered by the handbook are Park and Hopkins’ (1993) five instructional roles of animated visuals:

1. As an attention guide, the animated visuals can serve to guide and direct the learner's focus.
2. As an aid for illustration, dynamic visuals can be used as an effective aid to represent the structural and functional relationships among components in a domain of knowledge.
3. As a representation of domain knowledge, movement and action can be used to effectively represent specific conceptual details.
4. As a device model for forming a mental image, graphical animation can be used to represent system structures and functions that are not directly observable (e.g., blood flowing through the heart).
5. As a visual analogy or reasoning anchor for understanding abstract and symbolic concepts or processes, animation can make such concepts (e.g., velocity) become more concrete and palpable. (p. 767)

In this study, animation of the text, to render it “illustrative” should accomplish most of those instructional roles: (1) it should garner and focus attention; (2) illustrate the syntactical relationships between parts of speech; (4) assist in the formation of a mental image that represents the unobservable grammar transformation; and (5) serve to make the abstract concept of linguistic metamorphosis more concrete and somehow, observable.

The Cognitive Theory of Multimedia Learning

Mayer and Moreno (2002) summarize a decade of research findings in a collection of seven principles for the design of animation in instructional multimedia presentations. The goal of their meta-analysis was to focus on the role of animation in multimedia instructional messages, and to define the way that it can be used to promote understanding. They calculated effect sizes for 30 experiments conducted by Mayer and his colleagues over a ten-year period. All of the experiments tested college students' achievement via problem-solving transfer questions. To Mayer and Moreno, higher transfer score achievements constitute deeper meaningful learning, because transfer involves the active processing of new material, that is: selecting, organizing, and integrating it into the existing knowledge system. The instructional treatments covered the content areas of weather, mechanics, anatomy, mathematics, and biology. The researchers created four short, narrated, animated instructional messages that explained: (1) how lightning storms form, (2) how pumps work, (3) how car brakes work, and (4) how human lungs work. They also created two interactive computer games. One for children to learn basic math functions by playing with a bunny (Moreno & Mayer, 2000), and a botany game for teen and college students learning to design plants that can survive in various environments (Moreno et al., 2000).

Their seven principles for the design of animation in instructional multimedia provide the foundation to create presentations that are consistent with a cognitive theory of multimedia learning. The cognitive theory of multimedia learning has three theoretical foundations: (1) dual-channel assumption; (2) limited capacity assumption; and (3) active processing. The dual-channel assumption is in concert with dual coding theory. It assumes there are two separate channels for the intake of information, one for the visual/pictorial and a separate channel for auditory/verbal representations. The limited capacity assumption is aligned with the bottleneck view (Broadbent, 1958) of the attentional system; "only a few pieces of information can be actively processed at any one time in each channel" (Mayer & Moreno, 2002, p. 91). The third theoretical foundation assumes that meaningful learning is achieved through active processing of relevant material. Active processing refers to learner engagement through selection and organization of new information, and its integration into existing knowledge systems. A bottleneck, or limited view of the attentional system means that only a small part of the available

incoming information is ever attended to, therefore the rest of it is unavailable for processing. This limitation to learning is offset by the first assumption of dual-channel separation. The separation of the two modalities, visual and auditory, allows attention to twice the amount of input, because the two channels each have their own allotment of working memory. Visual input, such as animation, is more competitive with other visual input, such as text, than it is with auditory input, such as narration.

An alternate view (Moray, 1959, 1969; Treisman, 1960) holds that the attentional system serves to either organize or hold in chaotic limbo all that is ever seen, heard or otherwise taken in by the eyes, ears or other senses. In other words, all input is available for processing, but only some of it can be organized and integrated into the knowledge system at a single time. This means that some input may be remembered in an illogical fashion, that is, not associated with any other piece of knowledge in memory. Input seen, read or heard, but not learned, may have no associative connections, but it could still have referential nodes ready to become connections. Pictorial representations often behave this way, which may explain the clarity of research showing that illustration-enhanced instruction aids learning significantly (Plass, Chun, Mayer, & Leutner, 1998; Yoshii, 2000; Yoshii & Flaitz, 2002). Non-verbal propositions don't require a web of connections in order to remain in memory. A picture can "float" in the "back of the mind" and only later, spring to the forefront of consciousness, available for active processing. Although this alternative view of attention competes with Mayer and Moreno's second assumption above, it only reinforces the other two assumptions. Active processing can still occur using stored memories, especially if they are pictorial memories that were dually-encoded in synchronization with relevant verbal input.

The following seven design principles are consistent with cognitive theory of multimedia instruction, under either view of the attentional system. They are the summation of Mayer's collaborative animation research, and they serve as a guide to the effective use of animation for instructional purposes.

1. Multimedia principle
2. Spatial contiguity principle
3. Temporal contiguity principle
4. Coherence principle

5. Modality principle
6. Redundancy principle
7. Personalization principle

Multimedia principle. Learners achieve deeper learning from instructional texts, when words are accompanied by pictures. The addition of a "pictorial explanation (i.e., animation) [... substantially supports] learners' problem-solving transfer performance" (Mayer & Moreno, 2002, p. 93). Recognizing that not all animations are equal, Mayer's six other principles form the guidelines for making animations instructionally effective. In the present experiment, the static version of the instruction exemplified the multimedia principle, even though it had no pictures or animation. The instruction, or "textual explanation" was delivered on an audio channel, while the visual channel offered an entirely different text. Instead of merely reading what was already heard, the viewers were presented sample sentences, meant to illustrate the explanation. Offering dual channel input and verbal explanation accompanied by visual illustration, the static version also employs the multimedia principle as Mayer *et al.* envision it.

Spatial contiguity principle. Animations should be placed in close proximity to the texts that they are meant to illustrate. Moreno and Mayer's (1999) study revealed a moderate median effect (0.48) for the placement of text and its accompanying animation, concluding that when the pertinent text is found far from the relevant picture, e.g., at the bottom of the screen "learners must waste limited cognitive capacity in searching for the portion of the animation that corresponds to the presented text" (Mayer, et al., 2002, p. 95).

Temporal contiguity principle. Analysis of eight experiments conducted in four studies (Mayer & Anderson, 1991, 1992; Mayer & Sims, 1994; Mayer et al., 1999) yielded a strong and consistent effect for the aspect of simultaneous presentation of animation with corresponding textual narration (median effect size = 1.30). For this study, the audio presentation of instruction was carefully synchronized to the animation, in agreement with the temporal contiguity principle.

Coherence principle. Exclusion of extraneous words, sounds, music, decoration, etc., will minimize cognitive overload. In their analysis of five experiments (Moreno & Mayer, 2000; Mayer et al., 2001), Mayer and Moreno (2002) found strong and consistent support for the effect they term, the coherence principle. When explanations of how lightning works were

accompanied by background music, environmental sounds or interesting video, participant performance on problem-solving transfer tests suffered substantially (median effect size = 0.90). "The learner may attend to the irrelevant material and therefore have less cognitive resource available for building mental connections between relevant portions of the narration and animation" (p.95). The coherence principle was adhered to in the making of the presentations for this study. Redundant visual text and artistic features, such as colors, fonts, geometric shapes and gratuitous attention grabbers were systematically excluded from the programs, in order to create maximum coherence between the visual sample sentences and the auditory explanations.

Modality principle. Connections between words and their corresponding pictures are built better when they are presented in different modalities or channels. Viewing visual displays while reading visually presented text is challenging to the cognitive capacity. Since the eyes cannot be in two places at once, there must be an attention shift from the written word back and forth to the onscreen illustration. Text that is presented audially may be attended to while the eyes are free to view supportive, but different information. The modality principle of the cognitive theory of instructional multimedia operates within the limits of the attentional system to stretch working memory across two receptive channels (eyes and ears), presumably increasing cognitive capacity. A meta-analysis of six experiments in three studies (Moreno & Mayer, 1998; Mayer & Moreno, 1999; Moreno et al., 2000) showed support for the presumption (median effect size = 1.17). In presentations explaining how brakes work, how plants grow, and how lightning forms, animations were found to be more effective when accompanied by narration rather than printed (on-screen) words. Here again, both treatments of this experiment follow this principle by offering a verbal explanation in an auditory channel and presenting a visual sample supportive of the explanation.

Redundancy principle. This principle springs from two experiments (Mayer & Moreno, 2002) in which a presentation, explaining the formation of lightning, utilized on-screen printed words in addition to audial narration and animated depiction. The redundancy principle states that "less is more". The redundant visual text resulted in less, not more learning. According to the same rationale as the modality principle, the extra text adds an unnecessary burden to the visual processing mechanism. It hinders rather than helps the viewer to integrate the illustration with the explanation. In accordance with Mayer's redundancy principle, the verbal explanations

are given in verbal form only, while the visual text is comprised of sample sentences, which are different, but illustrative of the narrated text.

Personalization Principle. The seventh principle of the cognitive theory of instructional multimedia design is the preference for a conversational style of address over a more formal style. Constructed with first and second person pronouns, "I" and "you," such a convention is thought to involve the learner more personally. This principle holds that learners "work harder to understand an explanation when they are personally involved in a conversation" (Mayer & Moreno, 2002, p. 97). This program did not follow this principle, because the narration never used any form of address to the listener.

Congruency

In articles describing his research on animated computer instruction for Newtonian physics, Rieber has defined the purpose of animation to be dependent on the congruence of the content with the need for motion. Mayer's (1997) work agrees with this in so far as the motion of a pump or a piston in mechanical science is a field content that calls for animation to describe it to the greatest effect.

Language, an intangible element, is not typically thought of in terms of a physical process requiring motion to describe its different states. However, many structures of language can be seen as transformations or *movements* from one state to another. Thus, motion or animation is indeed called for to best describe some features of linguistic subject matter. Such a circumstance is called for primarily in the area of word order or syntax. When the grammatical structure of a language dictates that a certain type of word be placed in the sentence according to a strict or rigid rule, then the concepts of position and change of position become key elements of the content of instruction. Change of position may be represented as a motion from one position to the other, in effect, a transformation. The acquisition of language involves mastery of the ability to create novel utterances based upon the grammatical rules that govern the language involved. When a speaker wishes to communicate a novel idea by addition of an element, e.g., a time expression or a word of negation, which dictates a change in word order, a grammar transformation must take place. Some, but not all, grammar transformations are well represented by motion. In order to be congruent, animated input must show an appropriate relationship between mental representation and grammatical form (Hwang, 1999).

Mental Model Building vs. External Imagery

Animations that depict the “motions” of grammar transformation actually impose a mental model upon the viewer. Learners are no longer free to develop their own images of how things work, unaffected by the instructional presentation.

In the theater, directors will usually avoid seeing any performance of a play before envisioning their own production, played out in their head, as it were. Some would argue that effective language acquisition would entail the learners constructing their own mental models of grammar processes. Self-constructed models would be more readily recalled. That argument would be strong indeed if there were a guarantee that learners’ mental images were accurate (Shih & Alessi, 1994).

Schnotz and Grzondziel (1996) praise the usefulness of animation to support mental model construction and to ease the cognitive efforts involved in mental simulation, but they also warn of “the danger with animated pictures [in] that individuals are prevented from performing relevant cognitive processes by themselves and, thus, process the subject matter more superficially than with static pictures” (p.10).

Blaming oversimplification, Lai (2000) contends that dynamic visuals could lead to misconceptions. Lai’s learner-controlled CBI also allowed observation that animation of visual representation resulted in faster, i.e., shorter time spent viewing the instruction.

Processing Speed and Prior Knowledge

It is suspected that animation not only eases cognitive efforts but also speeds up the pace of cognitive processing as well. In accord with Lai (2000), Schnotz and Grzondziel (1996) report that a major feature of animation is faster processing of new subject matter.

By helping learners to comprehend a concept holistically, portraying relevant information simultaneously, animation also tends to shorten the time needed to process the information. Pilot testing in preparation for this study has shown that in a user-controlled CBI, learners moved considerably faster through the program under the animated condition.

Increased speed in the processing of new information may very well be more detrimental to mental model building than it is helpful for cognitive effort. Pilot testing for this study has also shown that, under the animated condition, students seemed to feel more confident about their understanding of the subject matter, as evidenced by faster processing speeds, but it was not

clear if that confidence would bear out in terms of production accuracy over time. They “get it” better now, but will they “know it” better later?

The ideal of graphically represented information is that everything is presented at once as opposed to the linear presentation of facts endemic to prosaic textual presentation. In the case of a textual graphic, such as figure 1, all of the text is presented at once, everything could conceivably be “read” at once, so all of the information is available simultaneously. Paivio conveys this by means of the overlapping circles at the right of the illustration. All associations in the nonverbal system are available simultaneously, while information in the verbal system is processed (and presumably retrieved) in a linear, hierarchical fashion – one thought leads to another.

This “simultaneous availability” of so much information is what makes the nonverbal structure so powerful as an organ of memory and recall. Knowledge that is symbolically represented in the nonverbal system supports memory associations that are helpful for reason and recall.

Research supporting dual coding theory has shown that knowledge that is presented in simultaneously available graphic form helps to stimulate the imagery that creates nonverbal associative memories, but researchers also warn that this simultaneous availability of information can be too much.

Learners with low prior knowledge must invest extra mental effort to digest and encode graphical information. “Students with limited domain knowledge sometimes view graphics as an excess complexity and incomprehensible information if the connections are not transparent to them” (ChanLin & Chan, 1996, p. 5).

Conjoint Retention Theory

Paivio's encoding theory concerns the processing of incoming information. It suggests ways that instructional material can be presented in order to maximize the intake of input. A tangent theory by Kulhavy, Lee and Caterino (1985), concerns the retention of processed information and the recall event for dually encoded (inter-connected) data. "The conjoint retention hypothesis is essentially a rendition of the dual coding approach (cf., Paivio, 1971), in the sense that linguistic/verbal and perceptual/spatial representation in the cognitive milieu are

treated as separable coding processes" (p. 29). The difference is that conjoint retention theory focuses more on the recall activity rather than the initial encoding process.

Dual task objectives. Kulhavy and his colleagues (Abel & Kulhavy, 1986; Kulhavy, Lee, & Caterino, 1985; Kulhavy, Stock, Peterson, Pridemore, & Klein, 1992; Rittschof & Kulhavy, 1998; Verdi & Kulhavy, 2002; Verdi, Johnson, Stock, Kulhavy, & Whitman-Ahern, 1997) have studied the learning of textual information using geographic maps. Maps are, at once, pictorial text adjuncts, as well as suppliers of additional (mostly spatial) information. An example of text content is a story about events in a town and its various buildings and map sites (e.g., church, townhall, etc.). The map contains features representative of the town, therefore it serves as a structural support of the text information, but it is also a thing to be learned in and of itself. In Kulhavy's work, the learners' tasks involve recall of both text features (events) and map features (spatial relationships). It is a dual task and his experiments have shown significant support for dual-coding and conjoint retention theory for recall.

One task was to reconstruct map information, and a second was to recall facts about the events in the story. Instead of the two disparate tasks causing twice the cognitive load, the dual encoding at the time of processing makes them both easier, because each task eases the other. The mapping of the verbal memories of events onto the visual map features at the time of learning provided twice the memory storage capability (dual-coding theory), and as the mental image of the map features helped to recall story events, the verbal memories helped to reconstruct and reinforce the mental image. Instead of suffering, both tasks benefit from one another (conjoint retention theory).

The text and the map have features in common that allow an overlay as depicted in Figure 2. Imagine that the circles marked "verbal information" were holes, and that the small

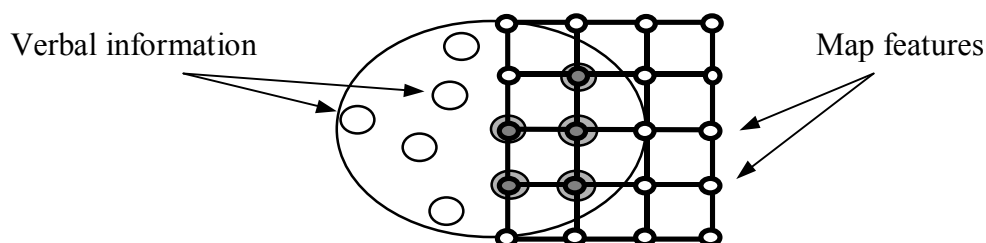


Figure 2. Conjoint Retention Theory for Map Features (adapted from Kulhavy, Stock, & Kealy, 1993)

circles at each intersection of the grid, marked "map features," were knobs that fit snugly into those holes. The map and the text, when semantically matched, would adhere to each other and support recall of both. This adherence creates conjoint retention.

Semantic matching. The key phrase above is "semantically matched." The verbal information can only have adherence to images that are meaningfully representative of the verbal proposition. Meaningful representation can be created either through convention (Winn & Solomon, 1993) or by relationship to reality (the degree of realism). The animations created for this study have a conventional relationship to the propositions explained. It is a convention to expect that a sequence of words will be perceived as having a left-to-right order, so that the word farthest left is in the "first position" and the one farthest right is "last." Another convention dictates that a movement toward the right signifies a movement toward "the end." The spatial arrangements of linguistic elements plays a large role in the establishment of meaning (Winn & Solomon, 1993).

Spatial conventions. An intent to examine the effects of animation raises the important issue of *what* to animate, as well as *how*. Linguistic elements, letters, words, phrases, etc, can be isolated and made to move, but the choice of what to isolate, and the way it is transformed, can not be arbitrary if the animations are to be meaningful in a determined way. Animation can be used to "suggest cognitive correspondences between mental spaces and real ones" (Morrison, Tversky, & Betrancourt, 2000, p. 2). In fact, in a study of the effect of spatial arrangements on viewers' interpretation of English and nonsense sentences, Winn and Solomon (1993) found that consistent conventions of spatial arrangement of objects, may "act with at least some of the force of grammatical rules" (p. 30), therefore such arrangements require specific prescriptions that reinforce the semantic content. To test the conventional expectations that influenced the design of the animations for this experiment, a small case study was performed. The details are described in the methods section of this document (chapter 3). The purpose of the case study was to determine the extent to which the animations were consistent with viewers' beliefs about the meanings of those movements.

Focus Shift

In a study of how graphic styles (*none, static, animated*) influence CBI of a molecular biotechnology concept (Basic Recombinant DNA), ChanLin and Chan (1996) discovered through interviews and observations during think-aloud protocols, that learners shift focus – switch their attention back and forth between animations and text. They noticed that some students began by utilizing the textual information available. These they termed “verbally oriented.” Those who started by studying the graphic presentations were considered “visually oriented.” They contend that “focus shift” between the two presentational formats requires more effort for verbally oriented learners especially if the graphics are animated.

Instructional graphics have been defined by Poohkay and Szabo (1995) as “any representation of an object, concept or process, as perceived through the eye, which does not rely on the use of text or numbers. Animation refers to the use of a series of graphics which change over time” (p. 1). The graphic animations to be tested in this study are textual animations or moving words. This means that they could form associative references in each symbolic subsystem while creating referential connections between them. Operating in both a verbal as well as nonverbal system, textual animations don’t require any focus shift. They are designed to be read even while they move. The observer’s conscious awareness is occupied with reading, or the verbal intake of stimuli, while the reader’s eyes are manipulated to move in a new symbolic pattern. A nonverbal image is planted along with the verbal message. This differs from Poohkay and Szabo’s view of graphic representation because, like Paivio’s letter “E,” text becomes a graphic when it is animated.

It also departs from Rieber’s view that animated subject matter be congruent to movement or that the concepts instructed are those that have transformational properties in the concrete world. Text doesn’t exist in the concrete, tangible world, only representations of linguistic symbols exist, such as printed letters and recorded words, and these things have no natural properties that could be said to “move” or transform in a determinate process. In this sense, text is not congruent to animation, yet animating text is conducive to learning according to dual coding theory. Animating text could force linguistic thought back into nonverbal imagery, forging the cross-system referential connections that would strengthen retention and recall.

Speelman (1997) is the only researcher thus far to examine the effects of animated text or “line-at-a-time” animation. With a posttest-only control-group design, she found a significant difference in the short-term retention scores of graduate and postgraduate instructional technology students, which she attributed to the effect of animating the text in the experimental instructional treatment compared to static textual presentation.

ChanLin and Chan (1996) note that, for verbally oriented students, the animations in their study were distractions, perceived as interrupters to students’ attention, requiring added mental effort. They observed that:

Some students constantly pointed at the verbal explanations when viewing animation. This behavior reflected the limited working memory. With limited free memory, students needed frequent access to text and animation so that they could keep these two information sources in working memory. (p. 9)

Their recommendation, in view of this focus shift, is to match the pace of visual information with the presentation of verbal information. “Matched pacing” or synchronicity of information sources is key to effective referential processing. ChanLin and Chan (1996) feel this is especially so for less experienced learners. Matched pacing is a major consideration in the design of the present experiment.

Redundant Narration

Matched pacing is achieved through redundant audio narration of visual information. Narration is considered redundant because it offers the same content as the visual display, but in keeping with the redundancy principle of multimedia theory, the narration is not identical to the visual information. That is, the audio is not simply an oral reading of the textual explanation, but it is equal in the amount of instruction that is offered, and is therefore, redundant. As Mayer and Anderson’s (1991) research shows, text and graphics presented in tandem enable students to construct better referencing connections (Mayer & Anderson, 1991; Packard et al., 1994). Mayer and Anderson also studied the interactive effects of animation with audio presentation of verbal information. In the conclusions from their (1992) study, entitled, “Animations need narrations: An experimental test of a dual-coding hypothesis,” they support the hypothesis of referential connections between visual with verbal stimuli. The significant achievement of their *animation plus concurrent oral narration* treatment group also suggests that learners were aided by the synchronicity of verbal and visual information. The narration sets the pace of the instruction. It

determines the amount of processing time allotted and it diminishes focus shift. Orally presented, verbal stimuli can be processed at the same time as graphical input.

A study by Okolo and Hayes (1996) lends merit to this view. The researchers evaluated the use of children's literature presented via one of three conditions: (1) an adult reading a book to the child, (2) the child reading a CD-ROM, silent version of the book with high animation, and (3) a static CD-ROM version of the book without animation. They found that children showed a preference for the animated computer version, spending almost four times as much time on the reading task than students in the adult-reader condition. However, it was in the latter condition that students obtained the highest scores on comprehension questions (1996). This suggests that narration adds a potent value to instructional presentation. The adult-readers in the abovementioned study were not recorded, however, therefore they offered the additional feature of live verbal interaction. The children could ask them to repeat words and to explain concepts.

Lai (2000) has recognized that “audio elements can gain and maintain attention throughout a multimedia program” (p. 204). Using narration synchronized to the visual presentation, Lai hoped to direct the viewers’ attention to details of the graphic representation and to influence the pace of student-controlled instruction.

While textual animation can control attention, narration can control pace. Both elements are capable of being used to direct attention and to affect the duration of the learner’s focus. Rehaag and Szabo (1995) used redundant audio to narrate a CBI mathematics lesson to 82 high school students. They reported a reduction in the time required to complete practice questions.

Childress (1995), Mayer and Sims (1994), and Rehaag and Szabo (1995) have also studied the issue of “concurrency” or synchronicity of narration with visual presentation. Rehaag and Szabo found positive effects, for lower ability students, if the textual explanations were simultaneously narrated (as opposed to not at all). The design for the narrated condition of this study reflects their findings for redundant audio or dual channeling.

Both treatments of this study incorporated recorded narration, which determined the pace of the treatment, matching the static presentation to the animated. Recording the narration not only kept it constant across treatment groups, but it eliminated the presence of a live instructor, whose gestures and expressions could be additionally informative.

What the Present Study Will Add to the Field

Animation and CBI

Research studies on the animation effect by investigators in the fields of physics, science, mathematics, medicine and microbiology (Enyedy, 1997; ChanLin, 1998a; ChanLin & Chan 1996; Hays, 1996; Large, 1996; Mayer, 1997; Mayer & Anderson, 1991, 1992; Mayer & Sims, 1994; Mayton, 1991; Nicholls, 1996; Packard et al. 1994, 1996; Rieber, 1988, 1989a, 1989b, 1996a, 1996b; Schnotz & Grzondziel, 1996; Szabo & Poohkay, 1995, 1996; Williamson & Abraham, 1995) have yielded support for Paivio's dual coding hypothesis, which states, indirectly, that two sources of input are better than one. Text and pictures are better than either one alone. Paivio's theory postulates distinctly separate mental mechanisms for processing verbal (textual) as opposed to visual (graphical) input.

Rieber's work examined the role of animation as a unique element affecting the reception of visual input that is distinct from static graphic input. Mayer's work investigated the effect of auditory text, a factor that is distinct from written text, while still a form of verbal input. Both of them reported beneficial attributes of dual coding of information.

Unique to this study is the content area of foreign language instruction. Previous research has examined the instruction of physical processes, which involve actions and consistent motions: motions that are "real" in that the processes actually do occur in a physical space. Pumps exist, and pistons do go up and down, and everyone agrees upon which way is up. The "motions" of grammar transformation are imaginary. The directions of the "action" model are arbitrary and could be unique to the speaker. People need not share the same idea of directionality in relation to grammar processes. (The finite verb doesn't necessarily rise "up" when displaced by a modal auxiliary.) Therefore the congruency of the process is not as clear in the field of language as is possible with active processes pertaining to science or physics. In terms of animation, this study borrows from research begun in physics, science, math and medicine, and extends it to the field of foreign language education. From dual coding theory, it draws the hypothesis that, although textual, linguistic transformation models can be made to represent graphic imagery, which means that grammar could be a content congruent to animation.

Another unique aspect to this study is the use of text rather than pictures as the object of animation. With the single exception of Speelman (1997), all animation research has dealt with *graphics*: diagrams or pictures. Speelman's dissertation study tested the effect of line-at-a-time animation as opposed to static presentation of textual explanations. She found a significant effect for animating the textual presentation of information technology content. The animated condition tested in the present study differs from Speelman's in that the textual *explanations* are not the objects to be animated. Instead, the *examples* are animated to illustrate the dynamic process. In this sense, this experiment is similar to all of the other studies that have examined the animation of *graphic objects*, with textual explanations held static. Because the content area's examples are *textual*, animating them transforms them into *graphic objects*, yet the study's focus remains animated text rather than animated graphics. Therefore, this study is the first of its kind; the first to test the effect of animating text to stimulate nonverbal association (creating a graphic visual out of a linguistic element), and the first to examine the use of animation in the field of computer-enhanced language teaching. The key inquiry: "What happens when you put text in motion?" is different from previous studies on the effect of animation, which ask: "What happens when you put graphics in motion?"

German L2 Pedagogy

The experiment conducted here adds to the field of foreign language pedagogy in the computer-based environment by providing evidence that describes the effects of the multimedia element, animation, on specific skills of German language acquisition, namely, performance of conjugation and syntactic rules during sentence rewrite tasks. The resulting advice should be most useful for designers of multimedia for German grammar instruction, but it may also be applied to the use of animation for multimedia grammar instruction for other foreign languages, such as Dutch, Swedish or English as a second language, especially when the point of grammar involves a consistent change of position or form. The study conducted here was a plan to isolate some particulars of animation for instructional purposes, more narrowly, for foreign language education, and more specifically, for German language grammar principles.

Summary

Dual coding theory is a description of how the mind perceives knowledge of the world in a mental representation. This review of the literature has examined how dual coding theory has informed educational researchers interested in the use of multimedia, particularly animation, to support learning and strengthen recall abilities. The implications of the theory for second language acquisition have been discussed and the applications of a dual coding approach for CALL, or foreign language teaching in the computer environment, have been considered.

This chapter has also reviewed literature from other disciplines (physics, biology, medicine, math and statistics) that investigated the effect of animation on learning outcomes. Substantive issues associated with the animation of text for grammar instruction have also been raised in this chapter. Alternate views of the structure of grammar have been described along with some approaches to teaching German L2 that are based on those views.

The question of congruency of subject to animation has been considered along with the issue of externally imposed imagery as opposed to self-constructed mental modeling. This research stands on the precept that novice L2 learners with low prior knowledge of linguistic infrastructure will benefit from externally composed imagery of dynamic grammatical principles (ChanLin, 1998b; Mayton, 1991; Paivio, 1990; Schnotz & Grzondziel, 1996). The instructional design conforms to the cognitive theory of multimedia learning (Mayer & Moreno, 2002) and adheres to conjoint retention theory's (Kulhavy et al., 1985; Kulhavy, Stock, & Kealy, 1993; Verdi & Kulhavy, 2002) requirement of semantic connection between information and illustration.

The next chapter provides detailed information about the participants. It describes the development of the instructional treatments and the tests that measure prior knowledge and post-treatment achievement. It also describes the data collection procedures that form the design of this research.

Chapter 3

Method

Introduction

This chapter is organized into five sections, including the research questions, participant information, instrumentation, and data collection procedures. This chapter also describes the development of the multimedia instructional program used in the experiment.

Research Questions

The following research questions were investigated:

1. What is the effect of *animation* of sample sentences depicting a grammatical process, explained in a concurrent narrative (audio) presentation, on test scores measuring a language learner's ability to rewrite German indicative sentences adding modal auxiliary verbs, compared to static presentation of the same sample sentences?
2. Is the effect of animating the sample sentences different for each of the two discrete tasks (conjugation and word order) involved in the rewriting process?

The first question represents the primary focus of the study and addresses whether animation provides benefits for conjugation and word order performance beyond those achievable through an otherwise identical, static presentation. The second question investigates animation more closely, trying to determine specific circumstances where animation might be helpful. The overall task consists of discrete parts (conjugation and word order), so it was possible to see exactly how animation affected completion of the task. It was expected that participants viewing the animated version would achieve higher scores on the criterion tasks of conjugation and word order when compared to participants in the static presentation group.

Participant Information

Participants were students enrolled in three sections of beginning German I at a state university in the southeastern United States. Ages of participants ranged from 18- 60 years, with a large proportion in their early 20's. Sixty-six students registered for one of three sections of the course designated GER1120. Due to drop-outs and absences, there were 44 participants available

to take the pretest. Three participants, who had taken the pretest, were subsequently absent at the next class period and consequently, did not view the treatments or take the posttest. However, there was one participant who viewed the instruction and took the posttest, but who was absent for the pretest portion of the experiment. One other student exercised the option offered in the study's written informed consent form ([Appendix A](#)), and accordingly declined to take the posttest.

Of the three class sections involved, sections one and two were daytime classes led by a female teacher in her 20s. Her classes met four times a week for 50 minutes per session. Section three was an evening class that met twice a week, two hours per session, and had a male teacher, over 60. The two instructors had roughly equal experience of two years each for teaching beginning German at the university level. Neither teacher had utilized technology in their classrooms prior to the study. Both teachers had been interviewed weekly to monitor whether modal verbs had been inadvertently taught or modeled within each section.

As a form of control for the variation within each section, the participants were matched into pairs, based on their class ranking. This ranking was calculated using four prior chapter exams covering structures of German grammar, scheduled as part of the regular course syllabus. The exam schedule was the same for each section. By the time of the data collection, all three class sections had been instructed and tested on the grammar and vocabulary of the first four chapters of their textbook, *Deutsch Heute* (Moeller, Liedloff, Adolf, Kirmse, & Lalande, 2000). Participants' scores on essays, oral exams and class participation were excluded from their class ranking. After ranking the students of each class section, they were paired by drawing a line under every second student. One member of each matched pair was randomly assigned to either the static or animated conditions and the other member was then assigned to the opposite treatment group.

There were 41 participants available to view the instructional treatments and to take the posttests, but only 36 represented matched pairs, (i.e., 18 matched pairs). As seen in Table 1, there had been 21 matched pairs available for the pretest, but three absences for the posttest eliminated three of those pairs, leaving three unmatched participants, in addition to the two unmatched participants of the pretest total.

Table 1

Number of Participants by Section

	Total	Sections		
		1	2	3
Registered in class	66	22	22	22
Drop outs	13	4	3	6
Absent for pretest	9	4	2	3
Available for pretest	44	14	17	13
Absent for posttest	3 ^a	0	3 ^a	0
Declined to participate	1	1	0	0
Available for posttest	41	13	15	13
Total of:				
Matched pairs available (pretest)	42	14	16	12
Matched pairs available (posttest)	36	12	12	12

^a One participant who had been absent for the pretest, was present for the posttest only.

All participants were given code numbers to protect their identities. The code numbers provided an indication of class ranking, class section, and treatment group. Test packets were then prepared, which were marked with the participants' code numbers but no names. The two coded test pairs (pre- and post-) were enclosed in a third sheet of paper containing instructions for participation in the study ([Appendix A](#)). To enable distribution via a roll call, this instruction sheet was marked with the names of each participant according to their coded assignments, but it also instructed them to discard the paper or retain it for themselves to preserve their anonymity. Since the participants had been assigned according to their ranking in their respective courses, and the test packets had to be prepared in advance, participant absence on the day of data collection resulted in unbalanced groups. Table 2 gives the sample sizes for the three class sections.

Table 2

Sample Sizes for Class Sections by Presentation Format

Presentation Format	Total n	Sections					
		1		2		3	
		n	%	n	%	n	%
Static	23	9	39	7	30	7	30
Animated	21	8	38	7	33	6	29

A pretest survey was administered to determine participants' prior knowledge of German and of other foreign languages, the time spent studying languages, the skill-levels achieved, and the amount of time spent living in Germany or other foreign countries ([Appendix B](#)). Tables 3 through 10 break the survey information down into greater detail, which describe the participants of each group.

Table 3 describes the participants' prior experience with German language learning. Of the 44 participants, 57% identified themselves as just starting to learn German. A little more than a third of all participants had previously studied German for 1-2 semesters, a little less than a third had lived in Germany for six months or longer, and 9% said that German had been used in their homes.

Table 3

Experience with German by Presentation Format

Option	Presentation Format				χ^2		
	Static		Animated			Total	
	n	%	n	%		n	%
	(n=23)		(n=21)		(n=44)		
Just starting	13	57	12	57	25	57	0.001 ns
Studied 1-2 semesters	7	30	8	38	15	34	0.03 ns
German used in the home	2	9	2	10	4	9	0.01 ns
Lived in Germany	7	3	6	3	13	30	0.02 ns

Note. Percentages total more than 100% because participants were able to select more than one option. * $p < .05$. ** $p < .01$. *** $p < .001$. "ns" = not statistically significant ($p > .05$).

Several respondents checked more than one category for this survey item. Three respondents had said that they were just starting to learn German, but they also checked the categories of more experienced learners. These included one who had been exposed to German in the home, but was just beginning to study it, and two who had lived in Germany for a matter of months but had not undertaken formal study. Seven respondents had lived in Germany between two and eight years, and had studied the language formally for two to twenty years.

The static and animation groups were identical with respect to the percentage of beginners, with 57% of each group identifying themselves as just starting to learn German. The *animated presentation* group had an 8% higher percentage of respondents who had studied 1-2

semesters, but this difference was represented by only one person. The groups were similar in terms of the percentage of participants who had used German in the home, and who had lived in Germany (3% of each group).

Table 4

Time Passed Since Last Course Of German Study of 1-2 Semesters (n=15)

How long ago?	Presentation Format		χ^2
	Static # of responses	Animated # of responses	
Since High school		2	2.29 ns
1 year	1		0.93 ns
2 years		2	0.004 ns
3 years		1	1.12 ns
4 years	1		0.93 ns
6 years	1	1	0.004 ns
7 years	1		0.93 ns
8 years	1		0.93 ns
9 years		1	1.12 ns
20 years	1	1	0.004 ns
25 years	1		0.93 ns

Note. *p<.05. ** p<.01. ***p<.001. "ns" = not statistically significant (p>.05).

Of the 15 participants who had studied German for 1-2 semesters, the survey asked them to estimate how long it had been since their last time of formal study. Table 4 shows a range between one and nine years, with a single respondent for nearly each number in between. Two responses merely stated "high school," and one from each group claimed a time span of twenty years since their last German class. There was also one participant who had not studied German for over 25 years. This same participant had some prior experience learning French and Italian, as can be seen in [Appendix B](#). Chi-square analysis revealed no statistically significant difference between the groups.

There were 13 participants (3% of each group) who had lived in Germany. Table 5 clarifies the length of time that these 13 were there. Of the seven in the *static presentation* group, four had spent only one year or less, while all six of those in the *animated presentation* group had spent at least two and up to eight years living in Germany. Of the other three members of the *static* group who had lived in Germany, one had spent three years, one eight, and the last, had

lived in Germany for 14 years. The *static presentation* group had a total of 24 years experience living in Germany, and the *animated presentation* group had a total of 25. This seems to be a similar amount, but the distribution was different for each group. There was a much broader spread of experience across the *static* group, while the experience of those in the *animated* group was more concentrated. Given the sample size, chi-square analysis did not show a statistically significant difference between the two groups.

Table 5

Time Spent Living in Germany

How long?	Presentation Format				Total		χ^2
	Static		Animated				
	n	%	n	%	n	%	
	(n=23)		(n=21)		(n=44)		
0 time	16	69.6	15	71.4	31	70.5	-----
3-6 months	3	13.4		0.0	3	6.8	2.94 ns
1 year	1	4.3		0.0	1	2.3	0.93 ns
2 years		0.0	1	4.8	1	2.3	1.12 ns
3 years	1	4.3	2	10.0	3	6.8	0.46 ns
4 years		0.0	1	4.8	1	2.3	1.12 ns
5 years	1	4.3	1	4.8	2	4.5	0.004 ns
8 years		0.0	1	4.8	1	2.3	1.12 ns
14 years	1	4.3		0.0	1	2.3	0.93 ns

Note. Percentages do not total 100% due to rounding.

*p<.05. ** p<.01. ***p<.001.

"ns" = not statistically significant (p>.05).

Table 6 shows that both groups had an equal number who considered themselves to be skilled in German, ranging from "survival level" to "near-native" ability. Again, the *animated presentation* group had less variability, with four out of five falling into the single mid-range category, "fluent, with poor grammar," but chi-square analysis did not show this difference to be statistically significant ($p > .05$).

Table 6

Self-rated Ability for German

Skill Level	Presentation Format				Total % (n=44)	χ^2
	Static		Animated			
	n (n=23)	%	n (n=21)	%		
None	18	78	16	76	77	-----
Survival Level	2	9	1	5	7	1.91 ns
Fluent (w/poor grammar)	2	9	4	19	14	1.00 ns
Near-native	1	4		0	2	0.93 ns

Note. *p<.05. ** p<.01. ***p<.001. "ns" = not statistically significant (p>.05).

Overall, there was only a single participant who had absolutely no prior exposure to any foreign language. All others had either lived in a foreign country for a month or more, or had taken at least one semester of foreign language instruction prior to the time of this study.

Table 7

Experience with second languages other than German

# of foreign languages	Presentation Format				Total % (n=44)	χ^2
	Static		Animated			
	n	%	n	%		
	(n=23)		(n=21)			
0	7	30	3	14	23	1.63 ns
1	8	35	11	52	43	1.37 ns
2	8	35	2	10	23	2.46 ns
3	0	0	4	19	9	2.35 ns
4	0	0	1	5	2	1.12 ns

Note. *p<.05. ** p<.01. ***p<.001. "ns" = not statistically significant (p>.05).

Table 7 shows participants' experience with languages other than German. All other participants had studied at least 1-2 semesters, or had some abilities in a second language through natural acquisition. There was only one participant who reported no experience with second language learning. Another participant reported no experience with language learning, but had lived in Germany over several summers. This table shows an imbalance between the two groups, with 30 % of the *static* group having no experience with foreign languages other than

German, compared to 14% of the *animated* group. This percentage actually represents only four people, but as shown in Table 8, the *animated* group also had four members who had studied three or more foreign languages besides German, compared to none in the *static* group. This shows a practical advantage for the *animated* group in their prior knowledge of other languages and their experience with foreign language study. Given the sample size, however, there was no statistically significant difference revealed through chi-square analysis. Table 7 also shows that more than three quarters of all participants had experience with at least one foreign language other than German.

Table 8 describes participants' experience with instructed second language learning other than German. This table shows how the languages are distributed between the two groups. Chi-square analysis showed no statistically significant difference between groups. Many participants had studied more than one language. [Appendix B](#) shows which languages and combinations of languages were studied by each participant.

Table 8

Experience with instructed second language learning other than German

Studied 1-2 semesters	Presentation Format				Total % (n=44)	χ^2
	Static		Animated			
	n	%	n	%		
	(n=23)		(n=21)			
No L2 instruction	8	35	4	10	27	-----
Spanish	9	39	9	43	41	0.06 ns
French	4	17	7	33	25	1.49 ns
Italian	4	17	4	19	18	0.02 ns
Latin	2	9	3	14	11	0.34 ns
Russian	1	4	2	10	7	0.46 ns
Greek	0	0	1	5	2	1.12 ns

Note. Percentages total more than 100% because some have studied more than one L2.

*p<.05. ** p<.01. ***p<.001. "ns" = not statistically significant (p>.05).

Participants were also asked about their prior experience living in countries other than Germany or the U.S. Three members of the *static* group and two from the *animated* group reported having lived in a foreign country other than Germany. No respondent mentioned any other German-speaking country, such as Switzerland, Austria, or Liechtenstein, nor was there mention of time spent in regions where German has a considerable presence, such as Belgium,

Luxembourg, or Kazakhstan¹. Of the five countries that were mentioned in response to this survey item, Malta, Poland, Romania, Spain, and Taiwan, each had only a single response and, except for the respondents who had lived in Malta and Taiwan, all were natives of the countries in which they had lived, and fluent in the official languages of those lands. Chi-square analysis showed no statistically significant difference between groups.

Instrumentation

This study included a pretest measuring meaning, conjugation and word order of modal verbs. There were two instructional treatments and then a posttest measuring modal verb conjugation and word order. The pretest differed from the posttest in two ways. It was shorter than the posttest in terms of point totals (40 points possible for the pretest, compared to 79 points for the posttest). The pretest also tested each criterion task in a manner that isolated one task from another, while the posttest fused the skills (conjugation and word order) into an integrated task.

Content Validity of Instruments

The test measures, pretest and posttest, and the treatment programs, static and animated, were evaluated by a panel of five university German instructors. Each instrument was modified by the researcher based on the panel's remarks, and then reevaluated by the same panel of teachers. To create the instruments, seven college level introductory German textbooks (*Deutsch Heute, Deutsch Na klar, Deutsch Plus, Kontakte, Neue Horizonte, Vorsprung, Wie Geht's*) were consulted along with at more than a dozen websites on German grammar, including the websites of the Goethe Institut and the AATG ([Appendix C](#)).

Pretest

The purpose of this measure was to determine if equivalency of prior knowledge across the static and animation groups had been achieved using matching and random assignments. The three areas associated with German modal verbs, their meanings, their irregular conjugations, and their effect on word order, were tested in isolation from one another to prevent the test itself from offering instructive clues. The pretest had been pilot tested in four class sections of

¹ There are 958,000 native speakers of German in Kazakhstan. An additional 100,000 are native speakers of Plattdeutsch (www.ethnologue.com).

beginning German and the results were viewed by the German teachers of the review panel. The pretest included six matching items to test the participants' prior knowledge of modal verb meanings (MG). There were 24 fill-in-the-blank items corresponding to the conjugation task (CM), and 10 sentence-writing items for the word order task (WO) for a total of 40 items. Internal consistency reliability (Cronbach alpha) was assessed for the overall pretest and for each of the three subtests. Given in Table 9, the Cronbach alphas for the overall scale were .86 and .46 for the meaning subtest, .87 for conjugation, and .77 for the word order task.

Table 9

Internal Consistency Reliability (Cronbach Alpha) for Pretest Scores by Group (n=44)

Variable	# of Items	Total Alpha	Item to Total	Animated Alpha	Item to Total	Static Alpha	Item to Total
Overall Test	40	.86	(-.09 to .67)	.90	(.06 to .65)	.82	(-.10 to .72)
Meaning	6	.46	(-.06 to .41)	.22	(.06 to .48)	.63	(-.26 to .56)
Conjugation	24	.87	(.16 to .61)	.91	(.00 to .77)	.79	(.00 to .68)
Word Order	10	.77	(.30 to .61)	.86	(.48 to .73)	.60	(.01 to .53)

The moderate value of the reliability coefficients spurred further examination into how individual items were functioning. Two items of the pretest ([Appendix D](#)) had negative item to total correlations. This negative value indicates that students who had greater overall levels of prior knowledge were more likely to miss these items. The two items were *will* (to want to) and *möchte* (to desire to). Details about these items are presented in the next section.

"Will." For the six items concerning meaning, one item (A4 = *will*) had a negative item to total correlation. This item had an answer that contained a cognate of the 3rd person form of the modal verb *wollen*, i.e., *will*. The incorrect answer "to have a will to" was chosen for the meaning of *wollen* more often by participants who tended to score above the average on the pretest. This is probably due to the interference of a vague prior knowledge of modal verb conjugations along with an inaccurate memory for their meanings. Of the two incorrect answers possible for the item, "to have a will to" was chosen in 87% of the cases where the answer to A4 was judged incorrect. Only 16% of the participants chose the correct meaning of *wollen* on the pretest. Given the negative value of this item, the scores for the meaning task were calculated

using only the other five items of this subtest. The Cronbach alpha with this item removed from the meaning subtest was .54.

"Möchte." For the 24 items concerning conjugation, one item (A7 = *möchte*) had a negative item to total correlation. Participants with a generally higher knowledge of modal verb conjugation were also more likely to provide the conjugated form of the word *mögen*, which is *mag*. The correct answer for this test was *möchte* not *mag*. Since the infinitive given was *möchten*, participants with no prior knowledge could be expected to provide the correct answer based on the fact that its conjugation follows regular, known rules. The use of the word *mag* shows that the participant possessed prior knowledge of the word *mögen*. Unmentioned in the instructional treatments, *mögen* is the origin of *möchten*, which is actually the subjunctive form of its parent word. The use of the word *mag* shows considerable prior knowledge, but it is incorrect based on the modal verb application. Given the negative value of this item, the score for the conjugation task was calculated using only the other 23 items of this subtest. The Cronbach alpha with this item removed from the conjugation subtest was .87 (.8713 after item removed, .8677 before).

Posttest

In contrast to the pretest, the posttest tested the two areas of conjugation and word order in an integrated fashion. An indicative sentence was given and the task was to rewrite the sentence with the addition of a given modal verb. The English equivalent of the correct resulting sentence was given below each item. This format was consistent with items of the test banks for four of the above mentioned textbooks, including the book used by study participants in their regular German classes. The posttest was pilot tested by four university German teachers, in addition to the researcher, in eleven class sections of beginning German over a three year time span. Items of the test were evaluated and modified after consultation among the teachers.

With 79 total items, the posttest ([Appendix E](#)) was nearly twice as long as the pretest. It also differed from the pretest because the discrete skills of meaning, conjugation, and word order, were integrated into a unified task, namely, to rewrite indicative sentences, adding a modal verb. In order to analyze the posttest errors made by participants in the pilot study, four university teachers of German looked at the errors and classified them using their own descriptions. Upon comparing the descriptions, it was determined that the conjugation task could

be further divided into three distinct error types: conjugation of the modal verb (CM), conjugation of the infinitive (CI), and conjugation of the separated prefix (CS). The word order task was also subdivided into two subtests: placement of the modal verb (WM), and placement of the infinitive (WI). The level of agreement among the four raters was 100%.

The main study's posttest consisted of 18 indicative German sentences with blank lines beneath each one. Each sentence was followed by a German modal verb in parentheses. Below the blank lines were English sentences, representing the equivalents of the German sentences correctly rewritten with the additions of the modal verbs specified. The 18 sentences yielded 18 items each for the four subtests, CM, CI, WM, and WI. Seven of the sentences, containing a separable-prefix verb, comprised the subtest CS.

Internal consistency reliability (Cronbach alpha) was assessed for the posttest overall scale (.90) and for each of the five subtests. Values and score ranges are shown in Table 10 for all participants and for each treatment group (animated and static).

Table 10

Internal Consistency Reliability for Posttest Scores by Group (n=41)

Variable	# of Items	Total Alpha N = 41	Item to Total	Animated Alpha N = 21	Item to Total	Static Alpha N = 20	Item to Total
Overall Scale	44	.90	(.07 to .72)	.87	(-.04 to .66)	.92	(.00 to .81)
Conjugation Modal (CM)	18	.80	(.03 to .50)	.78	(-.09 to .67)	.82	(.00 to .65)
Conjugation Infinitive (CI)	18	.92	(.44 to .86)	.88	(.00 to .88)	.93	(.27 to .84)
Conjugation Separable Prefix (CS)	7	.88	(.46 to .87)	.88	(.42 to .83)	.88	(.43 to .91)
Word Order Modal (WM)	18	.66	(.00 to .81)	.69	(.00 to 1.0)	.53	(.00 to 1.0)
Word Order Infinitive (WI)	18	.96	(.50 to .96)	.47	(-.12 to .59)	.53	(.61 to .98)

Qualitative Instruments

The pretest also posed questions concerning the participants' prior knowledge or experience with German in particular, and language learning in general ([Appendix F](#)). The

posttest invited participants to submit voluntary comments in writing, expressing their opinion of the presentation they viewed ([Appendix F](#)).

Instructional Treatments

Content. The instructional materials were developed by the researcher, a university German instructor with over ten years of teaching experience for introductory German and a specialty of expertise in German grammar. The multimedia program was created as an animated presentation and later, a static version was adapted from that. Both programs were revised after viewing by students and teachers of German, based on their questions and comments, some of which were recorded on audio tape. Remarks were also given by reviewers who had no prior experience with German L2 learning.

There were two instructional formats, *static* and *animated*, presented on large screens in two separate classrooms. Both treatments were divided into three sections based on each of the three task components: meanings of new words, conjugations of modal auxiliary verbs, and word order rules. The program PowerPoint was used to create all parts of the static treatment and two of the three sections of the animated treatment. The section concerning word order rules was created using the program Firestarter for the animated version, because it allowed point-to-point animation, a feature described further in the next section.

The treatment programs were judged by a professor of instructional technology with expertise in visual design, using the following criteria suggested by Boling and Soo (2001, p. 443).

1. The interface and terminology are consistent from screen to screen.
2. The layout of each screen makes good use of space.
3. Legibility and readability are high.
4. The display makes good use of contrast, repetition, alignment, and proximity.
5. Audio and video playback (where applicable) are of good quality.

The animations of text in the experimental treatment were also judged by the reviewer to ensure that they adhered to the following principles of purpose:

1. To attract, direct, or hold attention.
2. To illustrate the content of the text.
3. To convert a textual modality into a graphic modality.

Development. The instructional presentations were first constructed as ancillary to regular course materials. The mechanics of word order rules were illustrated using animation software (Authorware 3.5) for multimedia presentation, and shown to classrooms on an overhead projector screen. The instruction was presented to nine class sections over a period of five years, but only once was an experiment conducted with a static-presentation control-group. The instruction was first developed in Authorware because of that program's ability to create path animations, which is the crux of the issue for illustration of the motions of word order rules. Instruction for the other two task areas, meaning and conjugation, was created in PowerPoint for several reasons: it is easy to use, it has numerous animation features, and it is readily available to most teachers.

Authorware was then abandoned for the word order portion of the instruction, because it is not readily available. It is also very expensive and is quite complex to learn. A program created in Authorware would not be easy to replicate, except for a skilled programmer. PowerPoint, however, was not adequate to the job of animating the concept of word order motion. Its main limitation is that it can only animate an object for its entrance onto the computer screen. It cannot animate an object that is already visible on the screen. Therefore, nothing can move from one position on-screen to another. It can only move from limited directions off-screen, into a fixed position on-screen: Never from "here to there," only from "off to on." Since the crux of the word order rule, under focus here, is that a certain object moves from one specified position to another specified position, "here to there" animation is expressly required. The solution was found at the "11th hour" (August, 2001), when the software company, Coffeecup, introduced its imitation of Macromedia's Flash software, called "Firestarter." The program is easy to get through the Internet, is very inexpensive (\$25), and is extraordinarily easy to learn. More importantly, it enables the necessary "here to there" animation. It imitates Flash by creating .swf files for embedding into web-ready html files. The program can then be shown through the WWW or on a network with smooth and consistent presentation. The word order portion of the program, created for the animated version is consistent across platforms and easily accessible from any Internet terminal ([Appendix C](#)).

Imagery cueing. The static version of the instructional program utilized what Mayton (1990) has referred to as "imagery cueing strategy," similar to what ChanLin and Chan (1996)

have termed “metaphoric description.” The visuals are static, but the viewer is cued to imagine the motions or changes that make the process dynamic. The static modules created for this study employed this strategy by asking the learner, for example, to “imagine the verb moving to the end of the sentence.” This is also a design strategy intended to provide control between the *static* and the *animated* conditions. It provides a measure of “fairness.” It is only fair to assume that a teacher could induce metaphoric imagery to stimulate dynamic mental modeling, without the aid of technology.

Spatial conventions study. To test the conventional expectations that influenced the design of the animations for this experiment, a case study was performed. The animation sequence of the instructional program was segmented into five separate screens, one for each discrete motion or transformation. These also corresponded to the five steps of the grammar transformation. The text of the sample sentence was changed to scrambled letters forming nonsense words that were meant to convey no meaning whatsoever.

Five members (one staff, one professor, one student, and two TAs) of a university foreign language department helped with the case study. The participants were asked to view each of the five animations plus a sequence that combined the five into a single animated transformation. For each of the five discrete animations, they were asked to (a) supply the verb which would describe the animation, and (b) choose the most appropriate descriptive verb from a printed list. For the combined sequence, they were asked to (c) provide a verbal description of the event, and (d) rate the accuracy of a verbal description supplied by the researcher. Participant responses were recorded on a mini-CD.

[Appendix G](#) shows the results of this test, which confirmed the opinion of Winn and Solomon (1993) that “in the absence of semantic content, the interpretation of the diagrams was largely determined by syntactic rules of English” (p. 29). However, because the participants were involved in language learning in one form or another, each of them utilized grammatical metalanguage, which effectively expanded the convention from which they drew their imagery. While the “words” meant nothing, the string of letters was still considered to be a sentence by all viewers. Each string of letters was considered to be a word as delineated by the spaces between strings. In a sequence in which one word appeared atop another word and then rose to slightly above it, the upper word was judged to be “conjugated” from the lower word, by all participants.

Since people who confidently use the word, conjugate, generally know that it refers only to verbs, the same viewers would then know that the word in question is a verb, even without knowing its meaning. Participants also used the word, *conjugate*, to describe the action that took place after the word string moved to the end of the sentence, when the "verb" reverted to infinitive form. The purpose of this case study was to determine whether the animation design would be consistent with the viewers' conventional expectations. Since their descriptions of the overall event were similar to the explanation used by the researcher in the narrated instruction, it was adduced that the animation design had the best possible semantic connections to the verbal information.

Narration. A narrative script was written ([Appendix H](#)), based on recordings of three live presentations of the silent, instructional program. The recordings captured student questions and comments that were used to revise the program and to formulate the accompanying narration. The narration was written, performed and recorded by the researcher/programmer/content expert, with many of the sample sentences performed by a native speaker.

Both PowerPoint and Firestarter accommodate narration, but they do so using different file formats. PowerPoint uses .wav files, but Firestarter accepts only the .mp3 file format. A digital mini-disc was used to record the narration, and the software program, Total Recorder, was used to save the recorded sound files onto a computer's hard drive. They were sampled at 16 bit mono and edited with a combination of Total Recorder and the Windows internal sound recorder program. It took a third program, dBPowerAMP, to convert the .wav files into .mp3 files for use with the Firestarter program. These three programs are all readily available and are either freeware or inexpensive shareware. It may seem to have been a complicated operation, but it is actually an easily replicable procedure, involving onhand or inexpensive programs that are accessible to anyone. The digital mini-disc is not a necessary component, but it did allow spontaneous recording at locations away from the computer.

Pacing. Each of the (30 total) screens of the presentation was synchronized to the narration script and the pacing was adjusted according to comments from several viewers ranging from thoroughly novice to experts of German. With regard to speed, viewers universally suggested that too slow was better than too fast. After much adjustment, both versions of the program, as used in this study, ran precisely 20 minutes.

Content. The content of instruction covers the topic of German modal verbs by distinguishing between the three discrete tasks involved in their use. To use a modal verb, one must first know its meaning, then how to conjugate it, and third, where to put it and how that changes the word order. The content, created by an experienced German instructor, was revised to reflect student questions and comments, assembled from the previous nine different classroom presentations. For the purpose of the study, the instructional programs were also viewed and scrutinized by experts in visual design, foreign language instruction, instructional technology, and German language education, with revisions made following each review session.

Meaning. Both treatments, presented the topic of modal verb meanings, utilizing animation to a minor extent. Since there are no motions or transitions that can be said to clearly illustrate or exemplify the meanings of modal verbs, there were no animations created for this study that could be said to prompt dual coding associations. The meaning task was tested in the pretest, because it is a prime indication of prior knowledge for modal verbs, but it was not part of the posttest criteria. Therefore, the two treatments were identical with respect to meaning.

Conjugation. For each modal verb, there are four possible conjugated forms. The singular first person subject, *ich* (I), and the third person, *er, sie, es* (he, she, it) have an irregularity in the conjugation, including an irregular stem-vowel change for four of the six modal verbs. Another feature unique to the conjugation of modal verbs, for first and third person singular, is the absence of verb endings. The *ich*-form regularly carries the ending *-e*, while the *er*-form carries a *-t* ending in regularly conjugated verbs. In the case of modal verbs, neither form carries an ending, with the sole exception of the verb *möchten*, which carries an *-e* ending not only on the *ich*-form, but, atypically, on the *er*-form as well. The second person singular, *du* (you, informal) carries the regular ending *-st* along with the same stem-vowel change undergone by the first and third person singular subjects. All plural forms carry regular, that is, predictable, conjugated forms, as does the formal second person singular, *Sie* (you, formal). Therefore, modal verb conjugation involves four possible forms distributed over six subject pronouns.

Figure 3 represents the final screen of the conjugation portion of the instructional module. The shadowed box highlights the irregular stem-vowel changes undergone by four of the modals in the singular, informal forms. The pretest measured prior knowledge on this variable by

requesting the participant to provide conjugations of the four irregular modals for the six pronouns: *ich, du, er, wir, ihr, and sie*.

<i>ich</i>	<i>will</i>	<i>darf</i>	<i>kann</i>	<i>muss</i>	<i>soll</i>	<i>möchte</i>
<i>du</i>	<i>willst</i>	<i>darfst</i>	<i>kannst</i>	<i>musst</i>	<i>sollst</i>	<i>möchtest</i>
<i>er</i>	<i>will</i>	<i>darf</i>	<i>kann</i>	<i>muss</i>	<i>soll</i>	<i>möchte</i>
<i>wir</i>	<i>wollen</i>	<i>dürfen</i>	<i>können</i>	<i>müssen</i>	<i>sollen</i>	<i>möchten</i>
<i>ihr</i>	<i>wollt</i>	<i>dürft</i>	<i>könnt</i>	<i>müsst</i>	<i>sollt</i>	<i>möchtet</i>
<i>sie</i>	<i>wollen</i>	<i>dürfen</i>	<i>können</i>	<i>müssen</i>	<i>sollen</i>	<i>möchten</i>

Figure 3. Modal verb chart showing patterns and irregular conjugations.

Word order. Word order is the task-type under the sharpest focus in this study, because it is the aspect for which acquisition is most likely to be influenced by the use of animation in instruction. A pretest item (section C), that reflects word order only, consisted of jumbled sentences which must be ordered by writing each word on an appropriate blank in a punctuated row next to the jumble.

Data Collection Procedures

Three class sections of Beginning German I (GER 1120) participated in this experiment. Members of each class were ranked within section based on their scores from four prior chapter exams. The top two students of the rankings were partnered into a pair, the next two into another pair, and so on. For each pair, a coin was tossed and the first member was assigned a "1" or a "2" (representing treatment groups) depending on the result of the coin toss. The other member of each pair was assigned to the opposite group. Each group was then assigned by another coin toss, to one of the two treatments to receive either animated or static presentation. Participants were each given a letter introducing the researcher, explaining the basis of the study, and inviting them to be voluntary participants in the experiment ([Appendix A](#)). This letter was also read aloud by the researcher, during each section's regular class hour.

The two 50-minute daytime sections were given the letter and the pretest in one class session, and their treatment and posttest on the following day. The 2.5 hour evening class received the letter, pretest, treatments and posttest during a single class session.

The two daytime classes took their pretests in their regular classroom and were then separated for treatment and posttest. (The experimental group was taken to the classroom directly above the regular classroom. Both classrooms then had equal amounts of disturbance and distraction from the building construction occurring during this time.) Participants in the evening class were separated before their pretest, which they took in the same classrooms where they received treatments and posttests. The same two classrooms were used for all three sections.

The first third of the presentations was identical for both treatment groups. It concerned the meanings of modal verbs and utilized varying amounts of animation, distributed among the six modal verbs.

The second and third parts were animated for the experimental group, but presented only through static screens for the control group. Static means that all of the text presented on a single screen appears at one time, without transitional embellishment. Transitions between screens were subtle and identical for both versions. The presentations ran for 20 minutes.

Participants in each group were then given a posttest, which they completed immediately following the treatment programs. All participants completed the tests within the given time-periods.

Scoring. Each test was scored by two raters using scoresheets, and no marks were made on any of the test papers. Instead, ID code and scores for each participant were recorded on a separate form ([Appendix I](#)). The raters did not have a view of each other's marks while scoring. Discrepancies in rater scores were first checked for miscalculations. With 89 tests rated, there were originally 33 discrepancies. Examination of these discrepancies revealed that all but five of them were judgement errors (e.g., marking a correct answer "wrong") or errors of calculation (e.g., incorrect totals or subtotals) on the part of the raters. These 28 discrepancies were easily resolved, and the remaining five were rated by a third-party German teacher in the presence of the first two raters as well as a fourth-party German teacher. The five discrepancies were all found to be a matter of spelling, inconsequential to the type of error being scrutinized. For example, *kaufft* was judged by rater #1 to be correct because the answer possessed the necessary

components of initial consonant, proper stem-vowel, and the crucial t ending. However, because there are two f's instead of the proper spelling of only one f, the answer was judged incorrect by rater #2. Rater #3 (as well as the fourth-party teacher) agreed with rater #1 in all but one of the five cases. There was also one issue of handwriting. For the test in question, the answers that rater #1 marked as wrong were thought to be correct by rater #2 who recognized the handwriting and knew the participant's habit of writing o's that look like a's.

With a value of 1 for correct or 0 for incorrect, scores for each test item were entered first into an Excel spreadsheet. These values were then merged into an MS Word document, and then imported into the program, SPSS, for statistical analysis. The next chapter presents the results of this analysis.

Chapter 4

Results

This goal of this study was to investigate the effects of animation for a technology assisted German grammar presentation on students' understanding of modal verbs. The premise was that the features of animation effects (fly-ons, highlighting, etc.) would illustrate intangible concepts of grammar better than static textual representations (sample sentences) if those concepts involved motion or a change of state. The research hypothesis was that students' learning of the German language grammar concepts would be superior using animated effects and that their scores on a posttest concerning the conjugations and word order of modal verbs would be higher for the animated presentation type.

The first step of the data analysis was to determine if there was a difference between the two groups for their total pretest scores, as well as for the three subscale variables: meaning, conjugation and word order. The three subscales of the pretest were moderately correlated. The correlations are given in Table 11.

Table 11

Pearson Product Moment Correlations of Pretest Subscales (n = 40)

		1	2	3
1	Meaning	1.00		
2	Conjugation	.38*	1.00	
3	Word Order	.47**	.31	1.0

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

The general inquiry was divided into two questions. The first was whether animation could bring about higher test scores overall. Since the participants were brought together from three different class sections, their scores were also viewed by section as an independent variable. The overall posttest score was analyzed using a 3 (*section*) x 2 (*method*) univariate analysis of variance (ANOVA). Table 12 provides descriptive statistics for the total pretest scores by section and method.

Table 12

Descriptive Statistics for Pretest Total Scores by Section and by Method

Section		Presentation Type		Effect Size
		Animated (n = 19)	Static (n = 21)	
1	M	n = 6 56.58	n = 7 57.52	-0.05
	SD	18.44	17.29	
	Median	53.95	52.63	
	Range	36.84 to 84.21	39.47 to 92.11	
	Skewness	0.53	1.51	
	Kurtosis	-1.01	2.76	
2	M	n = 7 48.87	n = 7 48.87	0.00
	SD	13.15	18.78	
	Median	50.00	52.63	
	Range	31.58 to 73.68	28.95 to 81.58	
	Skewness	0.95	0.70	
	Kurtosis	2.05	0.02	
3	M	n = 6 53.50	n = 7 50.38	0.16
	SD	26.97	9.04	
	Median	53.95	47.37	
	Range	23.68 to 94.74	39.47 to 65.79	
	Skewness	0.41	0.76	
	Kurtosis	-0.59	-0.11	

Note. Scores represent percentage correct.

The second question was concerned with the specific tasks involved. Posttest scores were analyzed using a 3(*section*) x 2(*method*) multivariate analysis of variance (MANOVA) because the main task, rewriting German sentences with the addition of a modal verb, could be divided into five interrelated subtasks. The conjugation task was subdivided into the variables (1) *conjugation of the modal verb* (CM), (2) *conjugation of the dependent infinitive* (CI), and (3) *conjugation of the separable-prefix infinitive* (CS); the word order task was subdivided into the variables (4) *word order of the modal verb* (WM), and (5) *word order of the dependent infinitive* (WI).

Therefore, MANOVA was selected because it examines each variable as part of a system. MANOVA can assess whether there is a significant overall difference between the two group mean scores, and it offers a structured method to specify the comparisons of group differences for each subtask (dependent variables). In addition, MANOVA is "robust to modest violations of normality if the violation is created by skewness rather than by outliers" (Tabachnik & Fidell, 1989, p. 378) and the "SPSS MANOVA adjusts for unequal n " (p. 404).

Research Question 1

The first research question was: What is the effect of animation of sample sentences depicting a grammatical process, explained in a concurrently narrated presentation, on test scores measuring a language learner's ability to rewrite German indicative sentences adding modal auxiliary verbs, compared to static presentation of the same sample sentences?

Posttest scores were analyzed using a 3 (*section*) x 2 (*method*) ANOVA. Results indicated no statistical significance for a section by method effect ($p = .48$), method effect ($p = .19$), or section effect ($p = .40$). Table 13 provides descriptive statistics for the three sections by treatment group. Participants in all three class sections had high scores with means ranging from 77% to 87%. Section 1 had a larger range of scores than the other two sections, with a low score of 34, and a high of 90. However, the median score for Section 1 was in the 80s (81.01) as were the medians for the other two sections for both treatment groups. With the small sample size (9) for this cell (see Table 2), the mean was greatly influenced by the outlier.

Table 13

Descriptive Statistics for Posttest Total Scores by Section

Section		Presentation Type		Effect Size
		Animated (n = 21)	Static (n = 20)	
1	M	87.13	74.86	0.84
	SD	7.52	19.22	
	Median	86.08	81.01	
	Range	76-99	34-90	
	Skewness	0.15	-1.99	
	Kurtosis	1.17	4.30	
2	M	84.95	83.97	0.08
	SD	10.33	13.29	
	Median	86.08	87.34	
	Range	63-98	60-99	
	Skewness	-1.02	-1.43	
	Kurtosis	1.63	2.90	
3	M	81.86	79.02	0.25
	SD	12.88	10.04	
	Median	83.54	83.54	
	Range	58-98	63-91	
	Skewness	-1.31	-0.55	
	Kurtosis	3.21	-1.04	

Note. Scores represent percentage correct.

Effect Sizes

Table 13 also provides effect sizes for the differences in groups across sections. Effect sizes were calculated (using Cohen's $d = M_1 - M_2 / SD_{\text{pooled}}$) in order to measure the slight advantage shown by the scores of the animated treatment group. According to Cohen (1988), an effect size of 0.20 indicates a small effect, 0.50 indicates a medium effect, and 0.80 indicates a large effect for the treatment intervention with the higher mean score. The effect size was large for the difference between the *animated* and the *static* groups in Section 1 (0.84). However, it should be noted that the mean for the *static* group was pulled down by the extremely low score of 34%.

Research Question 2

The second research question was: Is the effect of animating the sample sentences different for each of the two criterion tasks (conjugation and word order) involved in the rewriting process? A 3 (*section*) x 2 (*method*) MANOVA was conducted with the *conjugation* tasks as the dependent variables, subdivided into CM, CI, and CS. The correlations for these variables are given in Table 14.

Table 14

Pearson Product Moment Correlations of Posttest Subscales (n = 41)

		1	2	3	4	5
1	Conjugation Modal (CM)	1.00				
2	Conjugation Infinitive (CI)	.38*	1.00			
3	Conjugation Separable Prefix (CS)	.19	.35*	1.00		
4	Word Order Modal (WM)	.27	.40**	.22	1.00	
5	Word Order Infinitive (WI)	.15	.62***	.19	.11	1.00

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

One assumption is that the covariances of these three dependent variables are equal across groups. Box's *M*-test indicated no statistically significant differences (Box's $M = 46.674$, $p = .221$). Analysis of the means revealed no statistical significance for the *section x method* interaction (Wilks Lambda = .928, $p = .863$), or the *method* effect (Wilks Lambda = .928, $p = .476$), or the *section* effect (Wilks Lambda = .622, $p = .13$).

A 3 (*section*) x 2 (*method*) MANOVA was also conducted with the *word order* tasks as the dependent variables, subdivided into WM and WI. The correlations for these two variables was .109 (Table 14). Box's *M*-test indicated no statistically significant differences in the covariance matrices across groups (Box's $M = 5.939$, $p = .951$). Analysis of the means revealed no statistical significance for *section x method* interaction (Wilks Lambda = .915, $p = .544$), *method* effect (Wilks Lambda = .958, $p = .483$), or *section* effect (Wilks Lambda = .883, $p = 0.366$). The posttest mean scores, standard deviations, medians, and score ranges are given in Table 15.

Table 15

Mean Achievement Posttest Scores of Treatment Groups (n=41)

Variable		Total n = 41	Animated n = 21	Static n = 20	Effect Size
Total Score	M	81.94	84.70	79.05	0.45
	SD	12.60	10.13	14.46	
	Median	84.81	86.08	83.54	
	Range	34.18 to 98.73	58.23 to 98.73	34.18 to 98.73	
	Skewness	-1.67	-1.09	-1.72	
	Kurtosis	4.16	1.76	3.90	
Conjugation of the Modal Verb (CM)	M	64.50	67.50	61.40	0.28
	SD	21.40	20.36	22.55	
	Median	61.11	66.67	61.11	
	Range	11.11 to 100.00	27.80 to 94.44	11.11 to 100.00	
	Skewness	-0.46	-0.48	-0.42	
	Kurtosis	-0.18	-0.42	0.11	
Conjugation of the Dependent Infinitive Verb (CI)	M	82.50	88.70	76.11	0.55
	SD	23.50	17.00	27.90	
	Median	88.89	94.44	88.89	
	Range	0.00 to 100.00	22.22 to 100.00	0.00 to 100.00	
	Skewness	-2.23	-3.33	-1.71	
	Kurtosis	4.67	12.53	2.40	
Conjugation of the Dependent Infinitive Verb with a Separable Prefix. (CS)	M	46.00	50.00	42.14	0.20
	SD	38.40	39.02	38.40	
	Median	42.86	42.86	35.71	
	Range	0.00 to 100.00	0.00 to 100.00	0.00 to 100.00	
	Skewness	0.05	-0.04	0.15	
	Kurtosis	-1.65	-1.62	-1.82	
Word Order of the Modal Verb (WM)	M	99.00	98.41	99.44	-0.26
	SD	4.00	5.01	2.50	
	Median	100.00	100.00	100.00	
	Range	83.33 to 100.00	83.33 to 100.00	88.90 to 100.00	
	Skewness	-3.60	-2.98	-4.50	
	Kurtosis	11.70	7.60	20.00	
Word Order of the Dependent Infinitive Verb (WI)	M	95.80	98.00	93.61	0.28
	SD	15.90	4.50	22.40	
	Median	100.00	100.00	100.00	
	Range	0.00-100.00	83.33 to 100.00	0.00 to 100.00	
	Skewness	-5.80	-2.34	-4.30	
	Kurtosis	35.10	5.30	18.60	

Note. Effect sizes: .2 = small, .5 = medium, .8 = large (Cohen, 1988). Scores represent percentage correct out of a 79 point test.

There were no significant differences between the two groups for scores on any of the subtest variables. The range of scores for each subtest reached a maximum of 100% and a minimum of 0% for three of the subtests: CI, CS and WI. Table 12 also shows the value for skewness, as a measure of how far the participants' scores depart from a normal distribution. Having a negative skewness means that the scores were "bunched up" toward the higher end, closer to 100% correct. The scores of the *animated* group had a larger negative skewness than those of the *static* group, in all cases except one. These four subtests showed a slight advantage for the *animated* treatment. Only CS, which had skewness for the total sample of .05, showed an approximately normal distribution for both groups.

Effect Sizes

The four subtests, with larger mean scores in the animated group, had effect sizes ranging from small to medium (0.20 to 0.55). The fifth subtest, WM, showed a small effect size (-0.26) favoring the static group. This was also the subtest which showed the highest kurtosis (20.0) and the greatest negative skewness (-4.5). Standard deviations for both groups were considerably higher for the conjugation tasks than for the word order tasks. The effect size for total score was 0.45 favoring the animated treatment.

Conjugation. Across the three subtests of the conjugation task *animation* was shown to bring about slight but non-significant advantages. For subtests CM and CS, the effect sizes were small, but a medium effect size (.55) was found for the CI subtest. This subtest also showed considerably higher kurtosis for the *animated* group (12.5 compared to 2.4), nearly twice as much negative skewness (-3.33 compared to -1.71) and only half as much variability ($SD = 17.0$ compared to $SD = 27.9$).

Word order. For both subtests of the word order task (WM and WI), the scores were very high in both groups. The *animated* group had a mean score of 98.0 ($SD = 4.5$) and the mean score of the *static* group was 93.6 ($SD = 22.4$). There was very little variability in word order scores overall for the *animated* group. Their scores for both subtests ranged from 83.3 to 100.0. The *static* group had even lower variability for the WM subtest of the word order task with scores ranging from 88.9 to 100.0, but the WI subtest showed high variability ($SD = 22.4$) especially when compared to the *animated* group mean score for WI ($SD = 4.5$). The difference in variability between the two groups for WI was the largest of any subtest with a 17.9 point

difference in standard deviations. The range of scores for the *static* group indicated that one participant scored 0.0 for this subtest, while no participant from the *animated* group scored lower than 83.3 on either of the word order subtests. Analysis of these subtests revealed no statistically significant differences. Values for WM univariate analysis for method effects were $F(1,39) = 0.69, p = .41$, and for WI, $F(1,39) = 0.73, p = .40$.

There was no statistically significant effect for treatment (method), or for section x method interaction. A statistical significance was found for the effect of section for the subtask of CS only. A complete listing of the *F*-ratios and probability levels from the series of 3 (*section*) x 2 (*method*) ANOVAs for each of the five dependent variables is presented in Table 16.

Table 16

F-values and Significance Levels for Series of 3 (Section) x 2 (Method) Posttest ANOVAs

Variable	Section x Method		<i>p</i>	Method		<i>p</i>	Section		<i>p</i>
Total Score	0.750	.479		1.780	.191		0.405	.670	
Conjugation	0.365	.697		2.065	.160		0.418	.662	
CM	0.713	.497		1.028	.318		1.478	.242	
CI	0.347	.709		2.511	.122		0.767	.472	
CS	0.098	.907		0.193	.663		4.775*	.015	
Word Order	1.603	.216		0.322	.574		0.631	.538	
WM	0.178	.838		0.618	.437		0.930	.404	
WI	1.576	.221		0.663	.421		1.064	.356	

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Posttest Survey

[Appendix J](#) shows the remarks that participants offered on the posttest survey when invited to add their comments about the presentation. An equal number of participants in each group (9) declined to submit comments. The comments were collected and randomized by a computer macro in MS Word ([Appendix K](#)). They were shown to a group of 5 people (staff, TAs and professors) who were asked to rate each comment according to a 5-point Likert-type scale

with values ranging from very negative (1) to very positive (5). Interrater reliability was assessed at .95 (intraclass correlation coefficient). The mean rating for the comments of the *animated* group was 4.7 ($SD = 0.36$) compared to 3.7 ($SD = 0.96$) for the comments of the *static* group. A t -test showed this difference to be significant at the .05 level ($p = .0031$) with a medium effect size. The means and standard deviations are given in Table 17.

Table 17

Mean Ratings of Participant Comments (n=23)

Group	<i>n</i>	Mean	<i>SD</i>
Static	11	3.69	0.96
Animated	12	4.68	0.36

Note. Effect size = 0.56

This difference in the opinions of the two groups toward the instructional presentation may be due to the novelty of the animation, although neither group had been receiving German instruction via computer presentation of any kind prior to the study. Therefore, both presentations were new to the participants. Nevertheless, the *animated* version elicited more positive comments than the *static* version. The effect size for this difference was calculated at 0.56, which indicates a medium effect, according to Cohen (1988).

The next chapter presents a discussion of the results, including the limitations of the research, the implications for German language pedagogy, and recommendations for further study.

Chapter 5

Discussion

This study investigated the effects of animation for a technology assisted German grammar presentation on students' understanding of German modal verbs. The premise was that many intangible concepts of dynamic grammar involve syntactic components that possess visuo-spatial characteristics. It was further speculated that these characteristics could be more effectively represented by animated versus static instructional presentations. The research hypothesis was that students would learn the foreign language grammar concepts better with animation. The value of the animation was empirically assessed in order to determine its effectiveness within the instructional design.

This study began with the animated version of the instruction. Throughout seven years of teaching German I and II, the researcher had created over 20 animated grammar presentations using PowerPoint, Flash, and Authorware software programs (Caplan, 1996). The intrinsic value alone made the utility and pedagogic value of the programs clear, but the ultimate benefit to learner achievement was not as obvious. The presentations aided the clarity of the instruction in several ways: (a) Everything was always legible, (b) the presenter never had to turn her back to the learners, (c) no details were forgotten or erroneously presented, (d) class time was well-spent and efficiently allotted, (e) illustrations were of high quality, in vibrant hues, and most importantly (f) 100% of the learners appeared to be paying attention to the presentation.

The last claim lay in the observations of the researcher. Because the presentations required the lights to be off, the participants had little opportunity for reading or other activities at their desks. Bathed in the light reflected from the projection screen, it could be seen that all heads were raised forward and all eyes were focused on the presentation. The abovementioned considerations spoke in favor of the use of multimedia-enhanced instruction. This study was an attempt to determine if learning benefits could also be attributed to such enhancement.

Limitations

Sample Size

The greatest limitation to this study was the small number of participants. Even with the procedure of matching of participants by their rank, the sample was too small to provide adequate power to detect a significant difference of treatment effect. Therefore, it is not conclusive from this study that animation has no pedagogical value because a type-II error may have resulted from the low sample size.

Content Area

This research did not have the goal of finding evidence for the positive effect of animation in general. The aim was to discover whether animation was beneficial to illustrate the particular feature of German word order in the use of modal verbs. This is a very specific content area, and, as such, the outcome does not extend very far beyond the realm of explicit German grammar instruction. Even the area of modal verb word order was limited in that only the present tense indicative was considered. Word order for questions, dependent clauses, and the perfect tense forms would require additional explanation. However, had the results of this study shown significant benefit for animation's effect on learners' understanding of word order, then it would have suggested that animation may also provide benefits in the case of other word order issues.

Ceiling Effect

The lack of statistically significant effects of animation may be due to the narrow scope of the task and the ceiling effect of the test items. The content instructed and the tasks that were tested were very elementary and may have been too easy to allow for a measurable effect of treatment. Since all members of both treatment groups had scores above 90% for *word order*, it can be concluded that animation was no detriment to learning for this subject matter, but it is inconclusive as to whether animation is necessary or significantly beneficial. Student scores did not suffer from the use of animation, and it is reasonable to believe that it would support learning of more complex tasks involving conjugation and word order, especially with modal verbs. Both the impetus and the design of this experiment began with the animated version, which, in the developmental pilot studies, proved to be very effective over standard textbook explanations and oral teacher-presentation for the content of German modal verb word order rules. A developmental pilot study utilized a pretest-posttest design comparing the animated and static

word order presentations showed considerable variability in posttest scores favoring the animated presentation. Pretest scores for both groups ranged from 0-5. For the *animated* group, posttest scores increased to a range of 5-9, while the *static* presentation group posttest scores, maintained the range of 0-5. The results of the pilot study formed the impetus to research further the area of animation for German modal verb word order and to investigate whether it would also have a beneficial effect for the aspect of modal verb conjugation.

The static version of the instruction was designed to mock the animated version in every way except for the motion of elements. In the process of development and review, both versions were modified to take maximum advantage of visual design principles and to follow what current research has suggested about educational multimedia and instructional design. The static version of the presentation produced posttest scores that were so high, that there was little room for the animation condition to show and advantage.

Multimedia Principle

An explanation of why the two treatments produced such equally high results was that both treatments adhered to the main tenets of the design principles of the cognitive theory of multimedia instruction. The theory's *multimedia principle* concerns the use of illustrations as accompaniment to textual information. Learners achieve deeper learning from instructional texts when words are accompanied by relevant pictures. The addition of a "pictorial explanation (i.e., animation) [... substantially supports] learners' problem-solving transfer performance" (Mayer & Moreno, 2002, p.93). Typically, this means that words are accompanied by pictures. The instruction, or "textual explanation," of each presentation was delivered on an audio channel through recorded narration, while the visual channel offered an entirely different text. Instead of merely reading what was already heard, the viewers were presented sample sentences, meant to illustrate the explanation. The static version also employed the multimedia principle because the audio presentation was different from, but supported by, the visual presentation, even though both were textual in format. The animated version added motion to the presentation of the samples, but it did not appear to further the multimedia principle of dual-channelled input. Both treatments offered a verbal explanation in an auditory channel while presenting a visual sample supportive of the explanation.

The coherence principle. Both instructional treatments followed the coherence principle, which precludes the use of extraneous words, sounds, music, and other decoration, in order to minimize cognitive overload. Redundant visual text and artistic features, such as colors, fonts, geometric shapes and gratuitous attention grabbers were systematically excluded from both programs to create maximum coherence between the visual sample sentences and the auditory explanations. Although it served to illustrate specific aspects of the subject matter, the animation in the experimental treatment could not be said to add coherence to any detectably significant advantage.

Redundancy principle. The redundancy principle states that "less is more." Redundant visual text may add an unnecessary burden to the visual processing mechanism. It hinders rather than helps the viewer to integrate the illustration with the explanation. The textual explanations were given in verbal form only, while the visual text was comprised of sample sentences, which were different, but illustrative of the narrated text. Here again, the animations of the experimental treatment did not add anything to strengthen the presentation in this regard.

Only the animated version can be said to involve dual coding, because the motion of textual objects creates a non-verbal image. Such an image can be stored in the non-verbal memory and used as a referential link to the accompanying verbal information. The static version utilized only a textual format, storing all of the information in the verbally represented system of memory. Associative connections are possible between the items of information, but no ties are created that refer to items in non-verbal memory. However, because it used both audio and visual modalities, the static version can be said to involve dual channeling. Since the linguistic subject matter primarily resides in the mental world of verbal representation, it may be that dual channeling of input is of primary importance in cognitive processing for language learning. Dual coding, in this experiment, did not produce any appreciable benefit beyond what dual channeling could provide. In that respect, animation could not be said to be of a value proportionate to the trouble and expense that it originally instigated. However, since the costs and the efforts associated with creating animated presentations have decreased, and the learners have expressed increased enjoyment for animated instruction, the intrinsic values appear to at least equal the investments.

Implications

For teaching, the implications of the results are that verbal instruction of some grammar principles can be very effective if presented in dual channeled format, i.e., more than one avenue, or modality, of input. This conclusion, in and of itself, does not promote the use of multimedia for grammar instruction because it could be claimed that an instructor's verbal explanation, accompanied by the textbook's visual modality, is already a combination of input avenues. Therefore, it does not take a computer to offer dual channeling. It can also be argued that sample sentences, written in a textbook or on a blackboard, offer non-redundant illustration of information, another principle of the cognitive theory of multimedia. Since multimedia, strictly speaking, only declares multimodality, e.g., hearing and seeing, it does not have technology as its prerequisite. Only animation of visual stimuli requires the use of computer (or film) technology. Since this experiment found no significant advantage for animation in this particular arena, it could be claimed that traditional teaching methods (teacher and text/blackboard) would be as equally effective as a computerized presentation.

This study did not compare traditional teaching methods (e.g., reading the textbook aloud in class) to the use of computer-presented instruction, so no claim can be made that technology is a superior teaching tool to traditional teaching methods. However, the universally high scores of participants in both treatment groups suggest that such presentation is certainly not harmful to learners' ability to process the material for immediate use, and the higher appreciation that learners expressed for the animated version lend merit to its use in German language instruction.

Perhaps it is less a matter of how the learner perceives a lesson than how the instructor prepares it. Both treatments of this study involved preparation time and design development well beyond what is customary for traditional preparation. This research suggests that, given a similar amount of time, planning, evaluation and revision, as well as the support of theoretical research, and the commitment of the instructor, many different teaching methods could provide significant benefits to learners.

The benefits of computer-assisted multimedia, therefore, are more obvious for the instructor, than they are for the learner. The planning of the presentation means thorough planning of the lesson. It may mean increased visibility, legibility, and clarity of textual explanations. It may involve superior quality of illustrations, better anticipation of learners'

questions, and more efficient use of time. Careful development can mean better preparation overall. The conclusion, then, is that quality preparation deserves the credit for effective presentation, rather than any singular aspect of presentation. Summing up current research on instructional multimedia, Moore, Burton, and Myers (2001) conclude that:

[L]earning may be unaffected by a particular media and that learning of any type can be achieved through a variety of paths (media) if the methods of providing information are well designed, have a theoretical base and are well executed. (p. 869).

Recommendations

The sample size used for this study was too small to detect a statistically significant effect for animation in relation to any of the tasks associated with the use of German modal verbs. It was anticipated that animation would benefit learners' understanding of German word order the most, and of modal verb conjugations at a secondary level. While there was not enough of a difference, statistically, to suggest an advantage, a small difference in the scores of the two groups for the conjugation task does suggest that further study into the effects of animation for conjugation alone should be undertaken with a considerably larger sample size. It is, therefore, recommendable to study the use of animated presentation for basic conjugation of German regular verbs. Instruction in regular verb conjugation typically takes place at the start of introductory level German courses. At such a point, the number of participants is not yet affected by dropout attrition, and the prior knowledge of participants is generally more equal, since study habits and other factors will not yet have come into play. Additionally, it is at the outset of German language learning that clarity of conjugation instruction would be of the most benefit to learners, in order to construct a knowledge base upon which to build new information (such as new verbs, irregular conjugations, and general rules of word order).

It would also be useful to study the use of animation for instruction of more complex aspects of German word order. The tasks of this study were elementary, but the potential of animation to depict transformation and motion could be used advantageously for higher level German word order issues such as: (a) Questions and commands (the modal comes first), (b) Modals in dependent clauses (the modal goes to the end), (c) compound-complex sentences (the modal goes to the end of the clause, not the end of the sentence), (d) modals in the past and conditional tenses, (e) modals in double infinitive constructions, and (d) modals in double

infinitive dependent clauses (the modal "jumps the line" to the place in front of the double infinitive). Animation may offer instructional designers a useful tool for illustrating some of these structures, which often present the instructor with difficulty in lesson planning³.

The high level of enjoyment reported by the animation group suggests that it has high intrinsic value. Such value may be exploited by instructors, as long as the design of the animation incorporates associations that are semantically relevant to the content. This requirement calls for further study into these relationships. It would be very productive to determine how specific elements of animation (individual motions and changes) are interpreted by viewers in relation to linguistic elements. The importance of such a step should not be underestimated in the design of educational animation research. For example, a study involving two different treatments of instruction, both animated, could reveal benefits to learning for specific forms of animation relative to specific grammatical features (e.g., comparison of "fade-ins" with "zoom-ins" in relation to conjugation principles). Animation, therefore, should not be viewed as a monolithic entity, but as a diverse construct of great variation, which calls for closer investigation of its specific semantic properties.

Computer-assisted multimedia presentation has many benefits to the teacher in terms of lesson preparation, and it bears no apparent detriment to the learners' ability to process the instruction. Learners seemed to appreciate the effort and enjoy the instructional format. However, it is unproductive to simply duplicate traditional textbook instruction in multimedia form, especially when the computer offers aspects that the textbook is unable to deliver. Animation is now readily available to the instructional designer, often to the average teacher, but the research attesting to how it should be used is not.

Another important aspect of multimedia, not available in a textbook, is interactivity. Instructional designers have the ability to create software that not only takes advantage of multimedia features, such as animation, but can also be responsive to the learner's own inquiries and commands. The original software program created by the researcher, which served as the impetus to this study, had user-control and interactivity as overriding properties. The animations

³ See message thread *Past Subjunctive*, begun May 24, 2002, posted to the AATG (American Association of Teacher of German) electronic mailing list, archived at <http://listserv.iupui.edu/archives/aatg.html>

used were the same as those used in this study, but they occurred in response to the learner's actions. The learner was required to drag the modal verb into the sentence at the correct placement, in order for the sentence to transform into proper configuration. This provided a form of practice along with immediate feedback, in that the animations could only be performed given the correct placement of the modal verb. The actions could also be repeated or reversed, in response to the learner's mouse commands, which provided a measure of user-control to the instruction.

In order to design multimedia instruction for German grammar, these issues of task complexity and interactivity need further study. It should be determined how animation works for other specific structures and tasks, how it works in concert with user-interactivity and user-control, and to what extent viewer appreciation of animation can affect learning. While interactive, animated programming has great pedagogical potential, it is not possible to speak about animation as an asset in itself. It is an important element, but it is also part of a system of features that multimedia affords. The use of animation requires and deserves further study.

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Appendices

GERMAN MODAL AUXILIARY VERBS

An Experiment In Computer Assisted Language Learning

By Lizz Caplan-Carbin

You are invited to participate in a study to test your **pre-instruction** and **post-instruction** knowledge of German modal auxiliary verbs. There are also a few questions concerning your experience with German language learning and with second language acquisition in general.

Following the **pretest**, you will be invited to view a presentation about German modal verbs, after which, you will be asked to take another test. This **posttest** is designed to test your immediate understanding of the new material.

This is an experimental study in second language acquisition, for which your participation is respectfully requested. The content of the study, modal verbs, is an important part of your German language curriculum, therefore, viewing the instructional presentation is a requirement of the course. However, your participation with regards to all testing instruments is strictly voluntary. That means that you do not have to take any of the tests involved in the study. Your grade in your German I course will not be affected in any way by your decision to accept or decline this invitation to participate.*

Should you choose to take part in this experiment, you will be assigned a code number, and your test scores will not be identifiable with your name. Your test scores, therefore can not be calculated into your course grade in any way.

Your sincere participation is requested so that your contribution to the knowledge gathered here may be accurately accessed.

There will be 10 minutes allotted to take the **pretest** and to answer the short questionnaire. The **presentation** will last 20 minutes, and then you will have 20 minutes to answer the **posttest** questions. Since this is a very tight schedule, the pretest must begin promptly at the start of the next class period.

Again, I ask for your cooperation and sincere effort, in order to provide the most accurate picture of the effect of instruction.

Thank you for your assistance with this study.

*When you turn in your posttest exam, you will be given a lottery ticket for a chance at one of three gift certificates to Mr. Dunderbak's German Restaurant, worth \$5, \$10, and \$15. The winning tickets will be drawn during the Phi Sigma Iota / German Club Weihnachtskaffee.

Appendix B.

Pretest Survey Responses

[Return to text](#)

Participant # group	Studied 1-2 semesters	Lived in Germany	German at home	Fluent/lacking grammar	Just starting	Studied 1-2 semesters	lived in ...	Near-native	Fluent	Survival level
11 01	hs									
12 01				0		L. & I.				
13 01				0		F. L. & G.				
14 01				0		S.				
15 01				0		S.				
16 01				0		S. I. & F.				S.
17 01	3 yrs.		1							
18 01				0		S.				
21 01	2 yrs.		1	1		F.				G.
22 01	hs.	8 yrs.	1	1		S.				
23 01	20 yrs.	3 yrs.		1		S. F. & R.				
23 01				0						S.
25 01				0		F.				
26 01				0		F. S. & I		P.		
27 01				0		S.	Spain	S.		Cz
31 01	2 yrs	2 yrs					Poland	E. (L2)	Pol.	
32 01		4 yrs.				R.				
33 01				0		I. & F.		I	Alb.	F.
34 01				0		L.				
35 01	6 yrs.	3 yrs.				S.				
36 01	9 yrs.	5 yrs.								
11 02	20 yrs					S. & I.				
12 02				0		F. & I.				
13 02				0		S. & F.				
14 02	7 yrs									
15 02				0					S.	
16 02	25 yrs					F. & I.				I.
17 02				0		S. & R.				S.
18 02				0		S. & I.				
19 02				0		Sp. & L.				
21 02			1	1	0	S.				
22 02		1 yr.								
23 02	8 yrs.	months				S.	Romania	E. (L2)	Rom.	G.
24 02				0		S.				
25 02				0				E. (L2)	S.	
26 02		6 mos.		0						
27 02		14 yrs.	1			L.	Malta	G.		
31 02	6 yrs.					F.				
32 02		months		0						
33 02	4 yrs.	5 yrs.								G.
34 02	1 yr.						Taiwan			C.
35 02		3 yrs.		1						
36 02				0		S.				
37 02				0						

Appendix C. *Relevant Websites*

To view the animated version of the word order instruction, point a WWW browser to the following URL:

<http://www.webgerman.com/study/modals.html>

Bookmarks to websites on German grammar:

<http://webgerman.com/germlinks/main.htm#grammar>

Animated German grammar presentations:

<http://webgerman.com/Presentations>

A. Check the box next to the most appropriate meaning for each modal verb.

dürfen☐ to be aware of☐ to be allowed to☐ to be subscribed to**können**☐ to be obligated to☐ to be able to☐ to be informed of**müssen**☐ to be obligated to☐ to be hoping to☐ to be interested in**wollen**☐ to be willing to☐ to be intent on☐ to be counting on**sollen**☐ to be supposed to☐ to be afraid of☐ to be ready for**möchten**☐ to wish for☐ to wait for☐ to plead for

B. Fill in the four blanks, next to each of the following six pronouns, with the proper forms of the four modal verbs at the top of each column.

	möchten	können	dürfen	müssen
1. ich	_____	_____	_____	_____
2. du	_____	_____	_____	_____
3. er	_____	_____	_____	_____
4. wir	_____	_____	_____	_____
5. ihr	_____	_____	_____	_____
6. Sie	_____	_____	_____	_____

Appendix D. (Continued)

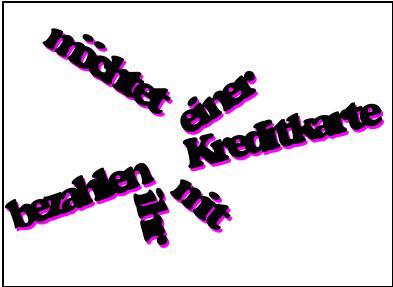
C. Compose sentences by placing a word onto each blank line next to the jumbles below.

1.  _____ .

2.  _____ .

3.  _____ .

4.  _____ .

5.  _____ .

Rewrite each sentence to make it match the translation beneath. The modal is given in parentheses.

1. Ich bleibe hier nur kurz. (dürfen)

I may stay here only a little while.

2. Du kaufst hier billig ein. (können)

You can shop cheaply here.

3. Es regnet bald. (müssen)

It must rain soon.

4. Ihr bereitet eure Hausaufgaben vor. (sollen)

You should prepare your homework.

5. Du fährst mit dem Auto aufs Land. (sollen)

You should drive into the country by car.

6. Ich warte nicht lang. (wollen)

I don't want to wait long.

7. Sie kommt morgen zum Mittagessen. (möchten)

She would like to come to lunch tomorrow.

8. Wir gehen heute ins Museum. (sollen)

We should go to the museum today.

9. Er kommt um acht Uhr an. (wollen)

He wants to arrive at 8:00.

Appendix E. (Continued)

10. Sie steht schon so früh auf. (wollen)

_____.
She wants to get up so early.

11. Man raucht in diesem Gebäude nicht. (dürfen)

_____.
One may not smoke in this building.

12. Ihr seht den Horizont noch. (können)

_____.
You can still see the horizon.

13. Ihr reist viel mehr. (müssen)

_____.
You must travel a lot more.

14. Sie verpassen die Strasse nicht. (können)

_____.
You can't miss the street.

15. Er fährt um acht Uhr ab. (möchten)

_____.
He would like to leave at eight o'clock.

16. Du bringst das mit. (dürfen)

_____.
You may bring that along with you.

17. Ich bezahle mit einer Kreditkarte. (möchten)

_____.
I would like to pay with a credit card.

18. Du machst die Tür bitte zu. (müssen)

_____.
You have to close the door, please.

Pretest Questionnaire**Participant** _____**1. How would you describe your prior experience with German?**

- ☐ Studied 1-2 semesters, a long time ago – how long ago? _____
- ☐ Spent some time in Germany – how long? _____
- ☐ German was used in the home setting – how often? _____
- ☐ Conversational ability, but need grammar skills.
- ☐ Just learning for the first time now.

2. What is your experience with language learning?

- ☐ Studied 1-2 semesters of _____ (what language/s?)
- ☐ Spent some time in _____ (what country/ies) how long? _____
- ☐ Near-native speaking ability in _____ (what language/s?)
- ☐ Fluent speaking ability in _____ (what language/s?)
- ☐ Survival level speaking ability in _____ (what language/s?)

Posttest Questionnaire

Comments about the test or the instructional presentation? _____

In order to test the conventional expectations that influenced the design of the animations for this experiment, a small case study was performed. The animation sequence of the instructional program was segmented into five separate screens, one for each discrete motion or transformation. These also corresponded to the five steps of the grammar transformation. The text of the sample sentence was changed to scrambled letters forming nonsense words that were meant to convey no meaning whatsoever.

Five members (one staff, one professor, one student, and two TAs) of a university foreign language department helped with the case study. The participants were asked to view each of the five animations, depicting a single motion of one word or part of a word, plus a sequence that combined the five into a single animated transformation. For each of the five discrete animations, they were asked to (1) supply the verb which would describe the animation, and (2) choose the most appropriate descriptive verb from a printed list. For the combined sequence, they were asked to (3) provide a verbal description of the event, and (4) rate the accuracy of a verbal description supplied by the researcher.

The sample sentence, consisting of invented, nonsense "words", appeared in the center of the screen as "Tuo Inkus tsiv jni blkii Uadkna." The word "yallic" appeared at the bottom of the screen. For each of the five screens, participants were asked to first describe the motion in their own words and then choose a descriptive verb from a printed list as follows:

Replace	Position	Emerge	Converge
Revert	Push	Exchange	Contact
Repress	Pull	Enmesh	Center
Release	Partition	Envelope	Crawl
Remove	Prepare	Engage	Conjugate

Participants were then shown an animation sequence combining the five separate motions into a single event. Shown the sequence a second time, they were asked to listen to a verbal description, synchronized to match the animation, and rate the accuracy of the description using a percentage value.

The following transformations were made throughout the presentation:

Tuo Inkus tsiv jni blkii Uadkna. → Tuo Inkus yull jni blkii Uadkna tsivic.

(yallic → yull) (tsiv → tsivic)

Participant responses were recorded on a mini-CD. The researcher explained the procedures to each participant and then remained silent during the presentation and recording of comments. Below is a transcript of the participants' responses recorded during the study. The numbers 1-6 represent the five screens and the combined animated sequence. For #7 participants were asked to rate how well they agree that the following sentence described the animated event: "This is a sentence, notice this position, this emerges from this, and takes the place of this, pushing it to the end, where it takes another form." The word "this" was accompanied by pointing to various parts of the screen.

Appendix G (Continued.)

Participants' Descriptions Of Animations

Participant 1

1. surrounding, emerge
2. conjugate
3. replacement, replace
4. moving position to the end, remove to end
5. changing the ending, conjugation thing, moving to the end and changing the ending
6. conjugation of the verb, moving the existing verb towards the end, making it agree with the second subject, or now modifying something else
7. 100%

Participant 2

1. a box coming up, a rectangle / emerge
2. is that maybe the base word? / exchange
3. push, exchange and replace
4. replaced one word and moved it / replace (move)
5. is that like a conjugation of a word? / conjugation
6. (silence)
7. 100%

Participant 3

1. emerge, zooming in on
2. conjugate, exchange
3. replace
4. moving
5. position, moving to the end, pushed to the end
6. replace, move
7. 100%

Participant 4

1. emerge, highlight
2. conjugate, emerge
3. replace, remove
4. remove, move
5. position, push
6. conjugation, replacement
7. 100%

Appendix G (Continued.)

Participant 5

1. highlighting
2. conjugate, conjugate
3. replace, replacing
4. exchanging and moving it, Replacing the one and moving it to the end of the sentence.
5. declension, conjugation
6. conjugation
7. 100%

Participants were also asked to give a verbal description of the entire animation. Here are four responses given when participants were asked to describe the entire animation sequence. One participant remained silent.

Participant descriptions of total animated sequence.

1. You're replacing "tziv" with "yull" moving that to the end, conjugating it in some way.
2. Zooming in on a word to replace it with another and then adding the word at the end in another form.
3. Conjugation of the verb, moving the existing verb towards the end, making it agree with the second subject, or now modifying something else.
4. Might be infinitive. The conjugation of the verb is replacing another, which was moved to the end of the sentence and was changed to another part of speech.

Summary of responses for each of the five screens

Emerging (x2) A box coming up Surrounding A rectangle Zooming in on Highlighting	Conjugate (x4) Exchange (x2) Is that maybe the base word?	Replacement (x5) Push Exchange Remove	Moving (x5) To the end (x2) Remove (x2) Exchange (x2)	Conjugation (x4) Another form (x2) Changing the ending Moving to the end (x2)
---	---	--	--	--

Slide 1

Modal Verbs

Meaning
Conjugation
Word Order

In this program you are going to learn about **modal verbs**. / There are three areas of consideration concerning **modal verbs**: / their **meanings**, / their special **conjugations**, / and their effect on **word order**.

Slide 2

Meanings of Modal Verbs

Modal verbs have meanings that express mood. **sollen**

Every modal verb can be combined with any action infinitive to form a modal verb phrase. **können**

A modal verb phrase expresses action and the mood or attitude toward that action. **dürfen**

möchten

wollen

müssen

Example: You understand. You should understand.

⤵ Action verb ⤵ Modal verb

The six modal verbs: **sollen, können, dürfen, möchten, wollen, and müssen**, / are verbs that express **mood**.

Every modal verb can be combined with any action infinitive to form a **modal verb phrase**. /

A modal verb phrase expresses action *and* the mood or attitude toward that action. /

For example, adding the modal verb “*should*” to the sentence “*You understand*”, expresses an *attitude* toward the action - “*You should understand.*”

“*Should*” is the modal verb, while “*understand*” is the action verb.

Slide 3

You <u>should</u> understand.	sollen
You <u>can</u> understand.	können
You <u>may</u> understand.	dürfen
You <u>would like to</u> understand.	möchten
You <u>want to</u> understand.	wollen
You <u>must</u> understand.	müssen

Any modal verb can be combined with any infinitive to express a new mood or attitude about the action verb. “*You should understand.*” differs only in mood from the phrase, “*you can understand*”. The following phrases each express a different attitude about the idea “*you understand*”:

Just as in English, the infinitive or *action verb* is interchangeable with any other infinitive, and the modal verb is interchangeable with any other modal.

Slide 4

sollen
should
ought to
to be supposed to

to do: **machen** **Er macht es.**
 He does it.

sollen **Er soll es machen.**
should He should do it.
ought to
to be supposed to

Modal verb **sollen** / means **should**. / It also means **ought to** / as well as **to be supposed to**. These three meanings are essentially equivalent. /

Take the action verb **to do**, / rendered as **machen** / in the simple sentence **Er macht es.** / **He does it.**

Add a modal verb / such as **sollen**, / meaning *should*, as in / **Er soll es machen**, / and the meaning is now - *he should do it*. Or - *He ought to do it*. Or even - *He is supposed to do it*.

Appendix H. (Continued)

Slide 5

<p>können can to be able to</p>	
to carry: tragen	Er trägt es. He carries it.
können can to be able to	Er kann es tragen. He can carry it.

Modal verb **können** / means **can**. / It also means **to be able to**. These two meanings are basically equivalent.

Take the action verb **to carry**, / rendered as **tragen** in the simple sentence / **Er trägt es.** / **He carries it.** /

Add the modal verb **können**, / meaning **can**, as in / **Er kann es tragen**, and the meaning is now / **he can carry it**.

- Or / **He is able to carry it.** /

Slide 6

<p>dürfen may to be allowed to be permitted to</p>	
to stay: bleiben	Wir bleiben hier. We stay here.
dürfen may to be allowed to to be permitted to	Wir dürfen hier bleiben. We may stay here.

Modal verb **dürfen** means **may**. It also means **to be allowed to** or **to be permitted to**. These three meanings are roughly equivalent.

With the action verb **to stay**, rendered as **bleiben** in the simple sentence **Wir bleiben hier.** - **We stay here.**

Adding the modal verb **dürfen**, meaning **may**, changes the sentence to **Wir dürfen hier bleiben** -- **We may stay here**. Also rendered as - **We are allowed to stay here**, and **We are permitted to stay here**.

Slide 7

<p>möchten would like to to have a desire to</p>	
to help: helfen	Ihr helft uns. You help us.
möchten would like to to have a desire to	Ihr möchtet uns helfen. You would like to help us.

Modal verb **möchten** means **would like to**. It also means **to have a desire to**, relatively equivalent meanings.

Along with the action verb **to help**, German **helfen**, the sentence- **Ihr helft uns.** - **You help us**, and the addition of the modal verb **would like to** meaning **möchten**, gives us **Ihr möchtet uns helfen**, or - **You would like to help us** /.

Slide 8

<p>wollen to want to to intend to</p>	
to become: werden	Du wirst begabt. You are becoming skilled.
wollen to want to to intend to to plan to	Du willst begabt werden. You want to become skilled.

Modal verb **wollen** means / **to want to**, / in the sense of / **to intend to**. Take the action verb / **to become**, / which is **werden** in German. The simple sentence / **Du wirst begabt** / or **You are becoming skilled**. / With the addition of the modal verb / **wollen**, meaning **to want to**, / **intend to**, becomes / **Du willst begabt werden**, and the meaning is now - /

You want to become skilled, in the sense of / **You intend to become skilled**. / Expressing intention, **wollen** is stronger and more definite than **desire** - **möchten**. For this reason, / **wollen** is often rendered as **to plan to** in English. /

Appendix H. (Continued)

Slide 9

müssen must to have to to be obligated to	
to give: geben	Sie geben mehr. They give more.
müssen must to have to to be obligated to	Sie müssen mehr geben. They must give more.

Modal verb **müssen** means / **must**. It also means **to have to** / as well as **to be obligated to**. These three meanings are basically equivalent.

Here is the action verb / **to give**, / -- **geben** in the simple sentence / **Sie geben mehr.** - / **They give more.**

Adding the modal **must**, / with **müssen**, / as in **Sie müssen mehr geben** expresses the meaning, / **They must give more.** Or - / **They have to give more.** / Or even - **They are obligated to give more.** /

Slide 10

sollen should ought to to be supposed to	können can to be able to
dürfen may to be allowed to to be permitted to	möchten would like to to have a desire to
wollen to want to to intend to	müssen must to have to to be obligated to

English also expresses mood with modal verbs, but they usually not always single words.

They are often a conglomeration of words, such as / **“to be supposed to”**, / **“to be allowed to”** / **“to have a desire to”** / **“to be obligated to”**.

German uses single words to convey these longer verb phrases. /

German also offers single words to convey multiple meanings for English speakers. / **To be allowed to**, / **to be permitted to**, / and **may**, are all rendered into German with the one word, / **“dürfen”**. /

To have to, / **to have an obligation to**, / and **must** are all equally expressed with the single German word / **“müssen”**.

Slide 11

Conjugation of modal verbs		
ich	-	Notice that the “er” form does not have its customary -t ending.
du	-st	
er	-	
Wir	-en	For modal verbs, the “er” form has the same endings as the “ich” form.
ihr	-t	
sie	-en	

“Möchten” is the only word that has the **-e** endings. The other modal verbs all have **no endings** for these forms.

The second thing to consider is the **conjugation of modal verbs**. /

Notice that the **“er”** form does not have its customary **-t** ending.

For modal verbs, the **“er”** form has the same endings as the **“ich”** form.

Since the upper-case, formal **“Sie”** form is identical to the plural **“sie”** form, only the lower-case word will be used in this presentation.

“Ich möchte” has the same verb form as **“Er möchte”**. The rest of the subject pronouns take their customary verb endings: **“du möchtest, wir möchten, ihr möchtet, and sie möchten.”**

“Möchten” is the only word that has the **-e** endings. The other modal verbs all have **no endings** for these forms, as the following slides will show.

Appendix H. (Continued)

Slide 12

<i>ich</i>	<i>soll</i>	<i>ich</i>	<i>möchte</i>
<i>du</i>	<i>sollst</i>	<i>du</i>	<i>möchtest</i>
<i>er</i>	<i>soll</i>	<i>er</i>	<i>möchte</i>
<i>wir</i>	<i>sollen</i>	<i>wir</i>	<i>möchten</i>
<i>ihr</i>	<i>sollt</i>	<i>ihr</i>	<i>möchtet</i>
<i>sie</i>	<i>sollen</i>	<i>sie</i>	<i>möchten</i>

Modal verbs "*sollen*" and "*möchten*" have regular conjugations.

Modal verbs "*sollen*" and "*möchten*" have regular conjugations.
ich soll, du sollst, er soll, wir sollen, ihr sollt, sie sollen

ich möchte, du möchtest, er möchte, wir möchten, ihr möchtet, sie möchten.

The stem vowel of both *sollen* and *möchten* remains unchanged for all conjugations

Slide 13

<i>ich</i>	<i>muss</i>	} stem-vowel change
<i>du</i>	<i>musst</i>	
<i>er</i>	<i>muss</i>	
<i>wir</i>	<i>müssen</i>	
<i>ihr</i>	<i>müsst</i>	
<i>sie</i>	<i>müssen</i>	

Except for "*sollen*" and "*möchten*", modal verbs have a stem-vowel change for the "*ich*", "*du*" and "*er*" forms.

Except for *sollen* and *möchten*, all of the other modal verbs have a stem-vowel change for the *ich*, *du* and *er* forms. /

Wollen for example, changes to *will* for *ich* and *er* forms and *willst* for the *du* form. "*ich will*", "*du willst*", "*er will*".

It takes the unique / stem-vowel change, o>i

But remains "*wir wollen, ihr wollt* and *sie wollen*." /

Modal verb *können* becomes *ich kann, du kannst, er kann*, but - *wir können, ihr könnt*, and *sie können*.

The *ich*, *du*, and *er* forms all undergo the equally unique / stem-vowel change - ö>a. /

Modal verb *dürfen* becomes *ich darf, du darfst, er darf*, but - *wir dürfen, ihr dürft* and *sie dürfen*.

The *ich*, *du*, and *er* forms all undergo the unique / stem-vowel change - ü>a. /

Modal verb *müssen* becomes *ich muss, du musst, er muss*, but - *wir müssen, ihr müsst* and *sie müssen*. /

The stem-vowel change undergone by the *ich*, *du*, and *er* forms is simply the loss of the original umlaut.

compare: *Wir müssen* and *ich muss*
ihr müsst and *du musst*

Slide 14

<i>ich</i>	<i>will</i>	<i>darf</i>	<i>kann</i>	<i>muss</i>	<i>soll</i>	<i>möchte</i>
<i>du</i>	<i>willst</i>	<i>darfst</i>	<i>kannst</i>	<i>musst</i>	<i>sollst</i>	<i>möchtest</i>
<i>er</i>	<i>will</i>	<i>darf</i>	<i>kann</i>	<i>muss</i>	<i>soll</i>	<i>möchte</i>
<i>wir</i>	<i>wollen</i>	<i>dürfen</i>	<i>können</i>	<i>müssen</i>	<i>sollen</i>	<i>möchten</i>
<i>ihr</i>	<i>wollt</i>	<i>dürft</i>	<i>könnt</i>	<i>müsst</i>	<i>sollt</i>	<i>möchtet</i>
<i>sie</i>	<i>wollen</i>	<i>dürfen</i>	<i>können</i>	<i>müssen</i>	<i>sollen</i>	<i>möchten</i>

Here are all of the modal verb conjugations, with the irregular stem-vowel changes highlighted.

Here are all of the modal verb conjugations, with the irregular stem-vowel changes highlighted.

Appendix H. (Continued)

Slide 15

Word Order

Since the **modal verb** must be conjugated to agree with the subject, it takes the pivotal **second position** in statement sentences.

The modal remains dependent upon its **action verb**, which is placed in the **last position** in all sentences, whether statements, questions or imperative commands.

“Dependent Infinitive”

A German sentence only conjugates one verb per clause, therefore, if there is a modal verb in second position, the dependent action verb is found at the end of the clause in its infinitive form.

A third important area to consider about modal verbs is their effect upon **word order**.

Since the modal verb must be conjugated to agree with the subject, it takes the pivotal *second position* in statement sentences.

The modal remains dependent upon its action verb, which is placed at the *end* of the clause, in all sentences, whether statements, questions or imperative commands.

A German sentence only conjugates one verb per clause, therefore, the dependent action verb is given in its infinitive form. It is then called a “dependent infinitive”.

Slide 16 ([modals1.html](#))

essen to eat

Der Junge isst ein Stück Kuchen.

The boy eats a piece of cake.

will
wollen to want to

Listen to the sample sentence, “**Der Junge isst ein Stück Kuchen.**”

The action verb “**essen**” (*to eat*) is conjugated match the subject, “**Der Junge**”.

To add a modal verb, such as “**wollen**”, conjugate the modal verb to agree with the subject of the sentence. - “**der Junge**”

“**will**”

Slide 17 ([modals2.html](#))

isst

Der Junge will ein Stück Kuchen essen.

The boy wants to eat a piece of cake.

wollen to want to

Next, imagine the conjugated modal verb placed into the **verb second position**.

The conjugated modal displaces the action verb, which is *pushed* to the end of the sentence, where it reverts to infinitive form.

“**Der Junge will ein Stück Kuchen essen.**”

Appendix H. (Continued)

Slide 18 ([modals3.html](#))

The action verb is now called a **dependent infinitive**.

Der Junge will ein Stück Kuchen essen.

*The boy **wants to eat** piece of cake.*

The action verb is now called a dependent infinitive.

“Der Junge will ein Stück Kuchen *essen*.”

Slide 19 ([modals4.html](#))

kaufen (to buy)

Das Brot kauft man täglich frisch.

One buys bread fresh daily.

soll

sollen (ought to)

Imagine the modal verb conjugated to agree with the subject of the sentence.

In the sample sentence, “Man **kauft** Brot täglich.”

The action verb “**kaufen**” (to buy) is conjugated to match the subject, “man”.

To add a modal verb, such as “**sollen**”, conjugate the modal verb to agree with the subject of the sentence. - “man”

“soll”

Slide 20 ([modals5.html](#))

Das Brot soll man täglich frisch kaufen.

One must buy bread fresh daily.

sollen (ought to)

Now, imagine the conjugated modal verb “**muss**” placed into the **verb second position**.

The conjugated modal displaces the action verb, “**kauft**” which is *pushed* to the end of the sentence, “**soll**”, is now the main verb...

“Das Brot *soll* man täglich frisch kaufen.”

Slide 21 ([modals6.html](#))

The action verb is now called a **dependent infinitive**.

Das Brot soll man täglich frisch kaufen.

*One **should buy** bread fresh daily.*

The action verb, “**kaufen**” is now the dependent infinitive.

“Das Brot soll man täglich frisch *kaufen*.”

Appendix H. (Continued)

Slide 22 ([modals7.html](#))

aufräumen (to clean up)

Das Mädchen räumt das Zimmer auf.
The girl cleans up the room.

muss
müssen to have to

In the next sample sentence,

“Das Mädchen räumt das Zimmer auf.”

the action verb **“aufräumen”** (*to clean up*) is conjugated to match the subject, **“Das Mädchen”**. It has a separable prefix **“auf”**.

“Das Mädchen räumt das Zimmer auf.”

To add a modal verb, such as **“müssen”**, conjugate the modal verb to agree with the subject of the sentence. - **“Mädchen”**...

“muss”

Slide 23 ([modals8.html](#))

Das Mädchen muss das Zimmer aufräumen.
The girl must clean up the room.

müssen to have to

Now, imagine the conjugated modal verb **“muss”** placed into the **verb second position**, and the action verb moving to the end of the sentence.

The conjugated modal displaces the **root** of the action verb, **“räumt”** which is **pushed** to the end of the sentence, and reunited with its own separated **prefix**, **“auf”**.

“Das Mädchen muss das Zimmer aufräumen.”

Slide 24 ([modals9.html](#))

Das Mädchen muss das Zimmer aufräumen.
The girl must clean up the room.

A separable-prefix verb will always become whole again in the infinitive form.

“Das Mädchen muss das Zimmer aufräumen.”

Slide 25 ([modals10.html](#))

Modal Verbs

Meaning können > can

Conjugation können > kann

Word Order trinkt

Die Frau möchte eine Cola trinken.
möchten

To summarize the topic of *modal verbs*: The three aspects to consider are:
Meanings, Conjugations, and Word Order.

This concludes the presentation on German modal verbs.

Thank you for your attention.

Appendix I.

Participant # _____

Score Sheet - PRETEST

A.

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

____ M

B.

1. ____
2. ____
3. ____
4. ____
5. ____

____ C

C.

W O

1. ____
2. ____
3. ____

____ W ____ O

____ M ____ C ____ W **Total**

A.

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

____ M

B.

1. ____
2. ____
3. ____
4. ____
5. ____

____ C

C.

W O

1. ____
2. ____
3. ____

____ W ____ O

____ M ____ C ____ W **Total**

Appendix I. (Continued)

Posttest Score Sheet

C = *conjugation*

CM – modal verb inflection

CI – dependent infinitive

CS – separable prefix infinitive

W = *word order – finite position*

O = *word order – infinitive position*

Participant # _____

Rater # _____

	CM	CI	CS	W	O
1.	__	__		__	__
2.	__	__	__	__	__
3.	__	__		__	__
4.	__	__	__	__	__
5.	__	__		__	__
6.	__	__		__	__
7.	__	__		__	__
8.	__	__		__	__
9.	__	__	__	__	__
10.	__	__	__	__	__
11.	__	__		__	__
12.	__	__		__	__
13.	__	__		__	__
14.	__	__		__	__
15.	__	__	__	__	__
16.	__	__	__	__	__

__CM __CI __CS

__C __W **Total**

Scale: 5 = very positive
 4 = somewhat positive
 3 = neutral
 2 = somewhat negative
 1 = very negative

Animated Group Comments

- | | |
|--|-----|
| 1. Great presentation helped me a lot, truly!!! | 5.0 |
| 2. I liked it. We should have this in class! Very helpful in seeing and hearing!
(Best way to learn!) | 5.0 |
| 3. Complete and thorough plus reinforced by the written test afterwards. | 5.0 |
| 4. I like this way of teaching better than the one we are using in class now. It was very helpful and very organized. | 4.8 |
| 5. The word order animation was very effective. | 4.8 |
| 6. Well presented. Wish I could have taken notes! | 4.8 |
| 7. It was very clear and I could understand and remember well from it. | 4.8 |
| 8. I liked the presentation because it used visual techniques to help teach language. I also like the fact that patterns in language usage were shown. | 4.8 |
| 9. The presentation was very helpful. I found it easier to understand with both verbal and visual instructions. | 4.8 |
| 10. I liked the different use of colors and how the words moved to the end of the sentence when replaced with the new modal verb. | 4.4 |
| 11. I liked the slides to the instruction. | 4.0 |
| 12. Good job on presentation despite computer problems. | 4.0 |

M = 4.7

Appendix J. (Continued)

Static Group Comments

- | | |
|---|-----|
| 1. I like it very much. I learn a lot from the visual presentation. The word order was presented very clearly and effectively. | 5.0 |
| 2. I understood the information much better after watching the presentation. | 4.8 |
| 3. This should be done more often. | 4.2 |
| 4. I enjoyed the presentation. Examples were good. | 4.2 |
| 5. I found it helpful. | 4.0 |
| 6. Well I thought it was very informative. The German voice that read was a bit monotone but otherwise I think it was great. I wish there was a recap at the end because I forgot how to spell mochte. Danke. | 4.0 |
| 7. Helpful. | 3.6 |
| 8. It was understandable. | 3.4 |
| 9. Pretty simple. | 3.2 |
| 10. Instruction was a little fast and confusing, wasn't too bad - was understandable. | 2.4 |
| 11. The presentation was boring -- should have more interaction. Possible practice of conjugation before taking the posttest. The second half was unnessecary [sic] as to the fact we saw the sentences and the "Word Order", construction in the first half. This should have been a second separate presentation for better clarifing. Very good power point. | 1.8 |

M = 3.7

Appendix K.**Comment Rating Scale**[Return to text](#)*Please rate the following comments according to the scale at right.*

Very Positive	Somewhat Positive	Neutral	Somewhat Negative	Very Negative
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a) I like this way of teaching better than the one we are using in class now. It was very helpful and very organized.	5	4	3	2	1
b) I like it very much. I learn a lot from the visual presentation. The word order was presented very clearly and effectively.	5	4	3	2	1
c) Well presented. Wish I could have taken notes!	5	4	3	2	1
d) I liked the different use of colors and how the words moved to the end of the sentence when replaced with the new modal verb.	5	4	3	2	1
e) Complete and thorough plus reinforced by the written test afterwards.	5	4	3	2	1
f) It was understandable.	5	4	3	2	1
g) This should be done more often.	5	4	3	2	1
h) I enjoyed the presentation. Examples were good.	5	4	3	2	1
i) I liked it. We should have this in class! Very helpful in seeing and hearing! (Best way to learn!)	5	4	3	2	1
j) The presentation was boring – should have more interaction. Possible practice of conjugation before taking the posttest. The second half was unnessecary [sic] as to the fact we saw the sentences and the "Word Order" construction in the first half. This should have been a second separate presentation for better clarifing [sic]. Very good power point.	5	4	3	2	1
k) Great presentation helped me a lot, truly!!!	5	4	3	2	1
l) I liked the slides to the instruction.	5	4	3	2	1
m) The word order animation was very effective.	5	4	3	2	1
n) Good job on presentation despite computer problems.	5	4	3	2	1
o) Instruction was a little fast and confusing, wasn't too bad – was understandable.	5	4	3	2	1
p) Helpful.	5	4	3	2	1
q) I liked the presentation because it used visual techniques to help teach language. I also like the fact that patterns in language usage were shown.	5	4	3	2	1
r) It was very clear and I could understand and remember well from it.	5	4	3	2	1
s) Well I thought it was very informative. The German voice that read was a bit monotone but otherwise I think it was great. I wish there was a recap at the end because I forgot how to spell mochte. Danke.	5	4	3	2	1
t) I understood the information much better after watching the presentation.	5	4	3	2	1
u) Pretty simple.	5	4	3	2	1
v) I found it helpful.	5	4	3	2	1
w) The presentation was very helpful. I found it easier to understand with both the verbal and visual instructions.	5	4	3	2	1

About the Author

Elizabeth Caplan received a Bachelor's Degree in Theater Arts from the University of Northern Colorado in 1979 and an M.A. in Germanic Language and Literature from Washington University in 1989. She began teaching German at University of South Florida in 1995, when she entered USF's pilot Ph.D. program for Second Language Acquisition and Instructional Technology.

While in the program at the University of South Florida, Ms. Caplan has been an instructor of German in the Department of World Language Education (WLE) in the College of Arts and Sciences. She is currently editor of *The Forum*, the newsletter of Phi Sigma Iota (PSI), an international foreign language honors society, and she has served as president of the local PSI chapter, Beta Zeta. She has also been the faculty liaison for the USF German club and the coordinator of WLE's German TAs. She made several paper presentations at regional meetings of the Florida Foreign Language Association (FFLA) and at national meetings of the American Council on the Teaching of Foreign Languages (ACTFL) and the Second Language Acquisition Research Forum (SLRF).

Ms. Caplan is currently an assistant professor of German at the University of Tennessee-Martin.