

AD-A285 954

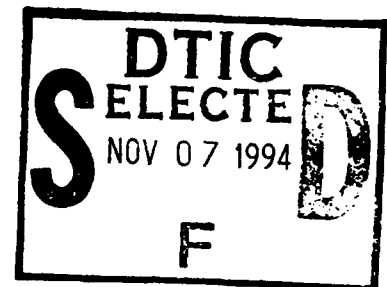
Technical Report 1010



A Review of the Literature on Part-Task and Whole-Task Training and Context Dependency

Ross C. Teague, Stuart S. Gittelman, and Ok-choon Park
U.S. Army Research Institute

October 1994



94-34346



338



United States Army Research Institute
for the Behavioral and Social Sciences

DTIC QUALITY INSPECTED 5

Approved for public release; distribution is unlimited.

94 34346 004

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

**A Field Operating Agency Under the Jurisdiction
of the Deputy Chief of Staff for Personnel**

EDGAR M. JOHNSON
Director

Technical review by

Douglas Macpherson
Dale R. Palmer

Accession For	
NTIS CRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and/or Special
A-1	

NOTICES

DISTRIBUTION: Primary distribution of this report has been made by ~~ARI~~. Please address correspondence concerning distribution of reports to: U.S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-POX, 5001 Eisenhower Ave., Alexandria, Virginia 22333-5600.

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U.S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

REPORT DOCUMENTATION PAGE			Form Approved OMB No 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (leave blank)	2. REPORT DATE 1994, October	3. REPORT TYPE AND DATES COVERED Final Sep 93 - Dec 93		
4. TITLE AND SUBTITLE A Review of the Literature on Part-Task and Whole-Task Training and Context Dependency		5. FUNDING NUMBERS 62785A 791 2231 H01		
6. AUTHOR(S) Teague, Ross C.; Gittelman, Stuart S.; and Park, Ok-choon				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences ATTN: PERI-II 5001 Eisenhower Avenue Alexandria, VA 22333-5600		8. PERFORMING ORGANIZATION REPORT NUMBER ARI Technical Report 1010		
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences 5001 Eisenhower Avenue Alexandria, VA 22333 5600		10. SPONSORING / MONITORING AGENCY REPORT NUMBER --		
11. SUPPLEMENTARY NOTES --				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.		12b. DISTRIBUTION CODE --		
13. ABSTRACT (Maximum 200 words) For this report, the part-task and whole-task training and context-dependent and context-independent presentation literature was reviewed. For part-/whole-task training, the influences of early research on the selection of training methods, relationships between training methods and task characteristics and trainees' individual differences, and different methods of part-task training were discussed. For context-dependent/independent presentation, early research findings, relationships between trainees' cognitive styles and the presentation methods, presentation methods and transfer of training, and presentation methods and trainees' attention were discussed. Generally, the research showed that whole-task training is the preferred method if the task is simple and can be reasonably approximated by the trainee. However, if the task is dangerous or highly complex and can be easily divided into subtasks, part-task training is the better choice. Context-dependent methods are favored over context-independent methods for recall and recognition. However, if the acquired knowledge and skills must be selectively applied in a variety of situations, context-independent presentation methods are recommended.				
14. SUBJECT TERMS Context dependency Computer-based instruction Part-task Presentation style Whole-task Training method		15. NUMBER OF PAGES 33		
		16. PRICE CODE --		
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT Unlimited	

Technical Report 1010

A Review of the Literature on Part-Task and Whole-Task Training and Context Dependency

Ross C. Teague, Stuart S. Gittelman, and Ok-choon Park
U.S. Army Research Institute

Advanced Training Methods Research Unit
Robert J. Seidel, Chief

Training Systems Research Division
Jack H. Hiller, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

October 1994

Army Project Number
2Q162785A791

Manpower, Personnel and Training

Approved for public release; distribution is unlimited.

FOREWORD

The Advanced Training Methods Research Unit of the Training Systems Research Division in the U.S. Army Research Institute for the Behavioral and Social Sciences performs research in the field of advanced training methods, including the application of emerging technologies. A major focus of the Unit is to enhance task performance through improved training by advancing theoretical knowledge and application of training methods and technologies.

For this report, the authors examined the literature on part-task and whole-task training and context-dependent and context-independent presentation of training contents. Their purpose was to organize the existing research in these areas and compile recommendations for the application to training development. The recommendations will be helpful for enhancing the training effectiveness of the United States Army and for developing future research in these areas.

This report is a partial product of a Basic Research Project funded by the In-House Laboratory Independent Research program.

EDGAR M. JOHNSON
Director

ACKNOWLEDGMENTS

The authors would like to thank our reviewers, Douglas Macpherson and Dale Palmer, for their thoughtful comments, which helped in the completion of this paper. Additionally, we would like to thank Dana Hamerschlag for her assistance in gathering literature and editing this manuscript.

A REVIEW OF THE LITERATURE ON PART-TASK AND WHOLE-TASK TRAINING AND CONTEXT DEPENDENCY

EXECUTIVE SUMMARY

Requirement:

As part of a research program investigating computer-based instruction methods and presentation types and to organize a base for further research into instructional design, this review examined the literature on part-task and whole-task training and context-dependent and context-independent presentation.

Procedure:

This paper is based on a wide range of literature obtained from a review of the ERIC, Psych Info, Management Contents, and ABI INFORM data bases. The number of articles discussing military related skills and abilities taught in the Army were limited. The early research influences, task and individual characteristics, and various methods of part-/whole-task training were reviewed. For the context-dependent and context-independent presentation review, early research influences, cognitive styles, attention, and transfer of training were examined.

Findings:

Overall, if a task can be approximated using a whole-task method, that method should be used because of the savings in cost and effort from not having to divide the task into segments and reintegrate the segments as needed in a part-task training method. Even if a task is appropriate for whole-task training, it may not be the best for all individuals. The consideration of individual characteristics is important, along with the analysis of the task structure, in determining what method of training will be most efficient for training a particular skill. If the task is highly complex or dangerous, part-task training is recommended. Tasks taught using part-task training methods must break the task into natural subunits for effective presentation and trainees must be given an idea of the whole system before presenting the parts of the task.

Training context is determined by the environment or the setting in which the training stimulus is presented. Although the review of the literature showed inconsistencies, a general view emerged that context-dependent methods are more effective than context-independent methods. This view was supported for the teaching of words and sentences, problem solving skills, and reading comprehension. When the knowledge and skills of task components are independent of one another and will be transferred to a different environment or to a variety of tasks, a context-independent method is generally better than a context-dependent method. When the knowledge and skills can only be transferred in an integrated form, and they can be learned as a whole, a context-dependent method is recommended.

An important consideration, made clear in this review, was that the selection of a training method should be based on the task characteristics, trainee characteristics, and individual differences, as well as on other situational variables.

Utilization of Findings:

This paper provides a synthesized review of the literature in the areas of part-task and whole-task training and context-dependent and context-independent presentation that will be useful for further research in these areas and will enhance the training capabilities of the United States Army.

A REVIEW OF THE LITERATURE ON PART-TASK AND WHOLE-TASK TRAINING AND CONTEXT DEPENDENCY

CONTENTS

	Page
INTRODUCTION	1
DEFINITIONS	2
Part-Task and Whole-Task Training	2
Context-Dependent and Context-Independent Training	2
RESEARCH FINDINGS	3
Part-Task and Whole-Task Training	3
Context-Dependent/Context-Independent Training	7
CONCLUSIONS	13
REFERENCES	21

LIST OF TABLES

Table 1.	Effects of Part-Task Training (PTT) and Whole-Task Training (WTT): Research Findings	17
2.	Effects of Context-Dependent Training (CDT) and Context-Independent Training (CIT): Research Findings	19

A REVIEW OF THE LITERATURE ON PART-TASK AND WHOLE-TASK TRAINING AND CONTEXT DEPENDENCY

Introduction

Computer technology continues to progress and offers much to training developers through increased flexibility in the design and presentation of instructional material. However, progress has also increased the likelihood of relying on technology to guide training development rather than using it as a tool to implement a learning strategy (Reiser, 1987). In many instances, training developers have allowed technology to supersede established learning theories and principles in the creation of a training program. Goldstein (1986) offered as advice to training designers: when presented with a special "do all" training device it should be thrown away and one should step back and assess the learner needs, the learner abilities and the material to be presented. His guide that training designers should rid themselves of an expensive piece of training equipment is one of principle and not reality. However, the point is well taken. Eberts and Brock (1987) stated that a poor instructional design that is automated is still a poor instructional design. It has failed to establish a setting conducive to learning. It is for this reason that training designers must develop an understanding of how to create the best learning environment.

When designing a training program, we must first investigate the characteristics of learners and subject domains to train, and then create a program is the most effective and efficient for the presentation of the training. Computer-based instruction (CBI) contributes much to the facilitation of learning. Perhaps the key benefit of CBI is the capability of presenting information to learners in a variety of ways. It is, therefore, important to assess what types of presentation strategies facilitate learning and how they should impact these presentation decisions.

Within the realm of learning and instructional strategies there are important variables that must be considered in the design of a training program such as: feedback,

presentation sequence, tutorial methods, evaluation procedures, practice procedures, display methods, part/whole training, context dependency, etc. Many research studies have been reported for each of these variables and most are summarized in review papers. However, few reviews, if any, are available for the part/whole training and context-dependent/independent presentation of information. The purpose of this paper is to organize and review the current research related to the uses of part/whole-task training and context-dependent/independent training methods and to compile recommendations for their efficient use and application in training development.

Definitions

Part-Task and Whole-Task Training

Part-task training consists of splitting a task into sub-tasks for presentation to the learner. Part training allows the learner to practice subsets of a task, in isolation from the whole. Whole-task training consists of presenting a complete task to learners so that they are able to practice the task as a single unit. Whole training eliminates the concerns of having to reintegrate the sub-tasks, which is necessary in part-task training methods (Newell, Carlton, Fisher, and Rutter, 1989).

Context-Dependent and Context-Independent Training

Context-dependency has been defined and operationalized in various ways in the learning research. Definitions of "context" have included: illustrations related to text (Hayes and Readence, 1983), sentences or set of words within which another word or sentence is presented (Rohwer, Shuell, and Levin, 1967); understanding of mechanisms of causality (Brown, 1990), and even the type of room within which learners are trained and tested (Smith, 1986). The difference between context-dependent and context-independent training rests in the setting or environment in which the information will be presented to the learner. Smith, Glenberg, and Bjork (Memon & Bruce, 1985-1986), described context as, "a kind of conceptual garbage can that denotes a great variety of intrinsic and extrinsic characteristics of the presentation and test of an item."

Context can also be defined as the relationship in presentation between system components and the system in which they normally exist. Park, Wilt, and Gittelman (1993), have defined a context-dependent presentation as one in which the learner practices or studies a particular task within the system that it exists. For example, using a computer lesson, these authors presented the components of an electronic circuit (e.g., transistors, gates) to a trainee, within the framework of the entire circuit, showing how they connect and react to the other pieces that make up the circuit. Context-independent training presented the parts of the system separate from the system. Using the electronic circuit example, trainees were presented with each of the components separately, learning about how each one operated, but this was done alone (independently) and outside the system within which they exist.

Research Findings

Part-Task and Whole-Task Training

The study of the differences between part and whole task training methods has been underway since the turn of the century. In 1900, Steffens (McGeoch, 1931) began the research by studying the optimum means of memorization and learning of poetry. She presented learners with either the entire stanza (whole-task) or with 8 line segments of a selected work (part-task), and found that whole-task training was the most beneficial for learning the stanzas. Following this, many studies were conducted in both Europe and America. However, most of these studies were fraught with methodological and objectivity problems, such as using only one subject per study (e.g. the experimenter) (Ash, 1988). A general conclusion that emerged, based on the research results, was that whole-task training was a better method than part-task training, although the studies taking place before the early 1930's showed only small differences in favor of whole-task training.

Ash (1988), in his review of the early research on part/whole-task training, reported that the research trends had remained relatively the same (investigations of the

basic differences between pure part-task and pure whole-task training methods) while researchers' interest had fluctuated. However, since the late 1930's, part/whole training research has moved in new directions as interest in it has increased. This was noted by Holding (1965) who stated that the categories of part and whole do not represent all of the possibilities of training methods and constraining ourselves to studies of pure part and pure whole methods limits the information that we can develop for efficient training. Knerr, Morrison, Mumaw, Stein, Sticha, Hoffman, Buede & Holding (1985) listed three additional reasons for the increased interest in part/whole-task training research, each related to the needs and concerns of the military during and after World War II. These were: 1) part training methods became more necessary due to increases in job task complexity, 2) training individuals with whole task methods was potentially unsafe and expensive, and 3) part training was useful for the upkeep of skills that are necessary only in rare instances (wartime performance). Thus, research shifted toward part-task training and investigation of the best means of segmenting and reintegrating a task, and the stability of learning that took place in these part training methods.

Crafts (1932) moved the research away from merely defining the conditions within which part- and whole-tasks are optimal toward recognizing the features of the tasks as the determinants of the difference between part and whole training methods. Crafts' work was also the launching pad for other researchers to continue studying the general learning principles that affected part and whole-task training. It was this line of research that Naylor and Briggs (1963) synthesized and incorporated into a theory of part/whole-task training method application supporting the conclusion that difficulty and organization of a task determined the optimum training method (Naylor & Briggs, 1963).

Task characteristics and part/whole-task training. From his review of the literature between 1930 and 1960, Naylor (1962) suggested that whole-task training was better for organized tasks across every level of complexity, while part-task training was better for training tasks with low organization and increasing task complexity. Naylor

and Briggs (1963) described "task organization" as the degree of interdependency that exists between internal components of a task. While this hypothesis has generally been accepted as the basis for the application of part/whole training methods, Naylor and Briggs' hypothesis has come under scrutiny and its generalizability questioned.

Stammers (1980) pointed out that the number of studies empirically testing Naylor and Briggs' hypothesis is limited, and tests of the hypothesis have produced contrary results (e.g. Anderson, 1968; Goggin and Stokes, 1969). Stammers concluded that: 1) a lack of operationally defined low and high task complexity, along with internal task organization, and 2) the difficulty in actually defining what task complexity and task organization mean are the reasons for the inconsistent results. Stammers' study suggests that a more in-depth interaction exists between variables involved in learning a given task (e.g., structural characteristics and difficulty levels of the task, trainee characteristics, etc.) than Naylor's hypothesis explains. The efficiency of part/whole-task training may function differently across different types of task domains and trainee abilities (Stammers, 1980).

McGeoch's (1931) review of the early part/whole-task training literature revealed several factors that influenced the choice of training method. These included: 1) trainee variables, 2) material to be trained, 3) a priori assessment methods, and 4) the interval between training and use of the learned skills and knowledge. While useful at the time for directing research, the generalizability of these factors was limited due to the poor experimental methods used in the studies reviewed.

Recent research has begun to look more carefully at the interactions between different types of tasks and trainee variables. Studies have shown greater effectiveness for part-task training methods for domains that were thought to benefit from whole-task training (Mane, Adams, & Donchin, 1989; Newell, et. al, 1989; Wightman & Sistrunk, 1987; Ash, 1988). These studies have shown that even for an organized task that is difficult, part-task training was superior to whole-task training. These findings partially conflict with Naylor and Briggs' hypothesis that states whole-task training is better for

organized tasks, as well as indicate that other variables may be important. For example, Newell, et. al., (1989), in research concerning interactions between part-task and whole-task training methods and task characteristics, suggested that part-task training should be used when the tasks can be represented with "natural" sub-units of the entire task. They stated that the "natural units of coordinated activity facilitate skill acquisition", which closely approximates Holding's (1965) view that part-task units should be complete units or "small wholes." Additionally, Newell, et. al. (1989) pointed out that without an overall understanding of the goal of the whole task and the "overall procedural strategy" of the entire task, the benefits of part-task training are short lived.

Individual needs and abilities have also been addressed in the selection of part and whole-task training methods. Nettlebeck and Kirby (1976) compared the effects of using part or whole-task methods to train mildly, mentally retarded workers to thread an industrial sewing machine. They found that part-task training reduced the time to learn the procedure and enhanced performance. Nettlebeck and Kirby also pointed out that the task of threading the machine was easily separated into independent sub-tasks and the sub-tasks were connected to one another by a common goal.

Types of part-task training methods. Wightman and Sistrunk (1987) studied three specific types of part-task training methods: segmentation (e.g. chaining), fractionation, and simplification. "Segmentation" is the process of teaching a trainee the final actions necessary in a task, reinforcing them, and then working backwards, adding the part of the task that preceded the final one and so on, until the entire task process is learned. "Fractionation" is the process of dividing a task into its sub-tasks that are normally done simultaneously. Each sub-task is trained individually before being recombined into the actual task. "Simplification" changes certain requirements of the task (e.g. reducing the number of dials that need monitoring, removing one or more operator actions) to make the task simpler and easier to learn. Once this "simplified" task is learned, the removed components are added back in until the task is complete. The authors found that for

training a perceptual motor task (e.g., simulated carrier landings), subjects trained in the segmented method had better transfer to the criterion task than those trained in a whole-task training method (Wightman and Sistrunk, 1987). This suggests that the segmented, part-task training method is most appropriate for perceptual motor tasks and that the type of task needs to be considered when selecting part-task methods.

As reviewed above, a general implication of the research findings is that part-task training is more effective than whole-task training for complex, difficult tasks that are not easily "graspable" by the trainee (see Table 1). This suggests that the advantages of whole-task methods shown in the early research may have been due to the type of task being taught. These tasks seemed to be easily understood as a whole (e.g. segments of prose), meaning that part methods were not necessary. Therefore, when a trainee is able to approximate the entire task, the artificial partitioning of the task into sub-tasks and their reintegration in the training process is not only unnecessary, but also may require a greater amount of time.

Context-Dependent/Context-Independent Training

The context of training has traditionally been determined by the setting or environment within which the training takes place (see Table 2). This section reviews early research regarding context dependency and discusses some of the ways context has been operationally defined and explored.

Early researchers were interested in discovering what effect the context of an item would have on recall of the item. For example, Swede and McNulty (1967) found that nonsense syllables presented in conjunction with item-specific colors enhanced recall. They suggested that this occurred because subjects attached their response to the color and not to the ambiguous stimulus. Their study also included shape as a contextual cue and they found that paired-associate learning was facilitated by the item-specific shape contextual cues as well. In coding research, this is also known as "complete redundancy", the knowledge of one attribute completely determining the value of the

other, which has been shown effective in aiding recall in target acquisition tasks (Christ, 1975).

Much of the research in context-dependent/independent presentation has been directed toward application in the classroom. This moved into full swing in the late 60's and 70's (e.g. Humphreys, 1978; Montgomery & Richman, 1979; Rohwer, et. al., 1967; Tenenbaum, 1977). Context, defined as the sentence within which the target word was imbedded, was shown to facilitate learning when presented during both the study and testing phases. Contextual cues were more effective when they were presented during both phases than when presented in the study phase alone (Rohwer, et. al., 1967). Montgomery and Richman, (1979), further advanced this idea of context and cues by presenting a stimulus (e.g. words) within a story. The results showed that when stimuli were presented within a related story, subjects performed better on the problem solving exercise than when the stimuli were presented without the story. That is, contextual cues presented during the study benefited later performance on related tasks.

Summarizing the context in reading comprehension literature, Morgan (1985) developed the following "Recommended Teaching Practices" to improve children's learning:

- 1) "Teach reading skills in context of sentences or stories, not isolated practice"
- 2) "Encourage children to predict or define a purpose for reading a selection"
- 3) "Let children become aware of how writers use context"
- 4) "Develop children's sense of story"
- 5) "Use one reading to create a context for another" (pg. 115).

Context dependent/independent instructional strategies have also been used for teaching foreign languages. Cerri (1989) stated that a reason for the difficulty in developing proficiency in another language is the lack of a one-to-one correspondence between words. Contextual information is particularly important for learning foreign

languages because the meanings of words in different languages may be dependent upon different contexts in which they are contained.

Context has not only been studied in terms of words, sentences and languages within which they are presented, but in terms of the illustrations and pictures that accompany text. Illustrations and pictures are thought to help learners order and organize text by increasing student involvement with the content of the text. Research has confirmed that learners have greater recall of information when text is supplemented with illustrations (Hayes & Readence, 1983).

Context and learning strategies. Researchers have investigated the benefits of context-dependent strategies in teaching memory strategies and problem solving skills. Studies have shown that context-independent strategies such as mnemonic peg-word strategies (e.g. methods of loci) and hierarchical retrieval strategies (e.g. clustering of data into categories) facilitate learning (Canelos, Taylor, and Altschuld, 1982). "Context" in this instance refers to meaningful organization of the content elements to be learned. These strategies are related to the internal cognitive representations of information. Contextual information or cues were shown to facilitate the retrieval of schemas necessary for solving related problems particularly when the context for the problem is similar to that experienced in the training. Spencer and Weisberg (1986) suggested that while possession of relevant schemas is necessary to solve a problem, possession itself is not sufficient to bring about successful transfer since the schemas need to be retrieved and applied to the given problem solving situation.

Context and recall. The research suggests that learners are less able to recall information when they are questioned in a context dissimilar to the one in which they studied (Smith, 1984). Several techniques have been used to facilitate context dependent memory, such as the context-recall technique and the multiple input contexts technique. Context-recall techniques are methods used to remember the context within which the learner was originally taught rather than actually being present in that location. This is

done by verbally telling subjects to visualize the room that they were in when they learned the material. Multiple input context techniques present the initial learning material in a variety of contexts with a goal of the material not being associated with a specific context. Research has shown that increasing the number of subjective organizations improves recall (Watkins & Watkins, 1975; Tulving and Pearlstone, 1966). Subjects' recall was enhanced as the number of retrieval cues was increased. Smith (1984) compared context recall techniques with multiple input context techniques for improving context-dependent memory. His results support the assumption that, in both methods, subjects are induced to make use of contextual retrieval cues that would not otherwise be used. However, successively experienced environments may lead to more contextual cues stored in memory, reducing the accessibility of these cues. The result may be interference in memory causing forgetfulness. Finally, context-dependent recall was not shown to be removable by these two methods (context-recall and multiple input techniques). Thus, although context cues are useful for recall, their inaccessibility seems to reduce their usefulness for recall.

Context and recognition. Smith (1985) pointed out that while the majority of research has shown recall of material is better if tested in a similar environment to that in which it was trained, these studies have not found the same relationship between context and the memory used for *recognition*. Real-world experience supports the idea of recognition memory, but this memory, in terms of context-dependency has not been found in the laboratory. By testing subjects in a shallow-processing short-term memory task instead of the long-term memory task that has traditionally been used, Smith (1986) found that context-dependent recognition does indeed occur in the laboratory. As a result, the type of processing that occurs is more important for recognition than is the actual context.

The effect of contextual cues for recognition memory has also been shown in facial memory tests. Memon and Bruce (1985-86) reported research in the area of facial

recognition in terms of eyewitnesses to crime. When persons were shown in a context (wearing a particular set of clothing and running from a bank), they were better recognized as the criminal than when the same person was shown in a scene out of context (different clothes, different location). They warn, however, that while "hits" increase when original context is reintroduced, so do "false alarms" meaning that innocent people may be identified as the criminal. Increased false alarms may be a result of the witness focusing on the context (e.g. picture, environment) rather than the face.

Context and cognitive styles. The question has been asked if persons with different types of cognitive styles are more or less affected by learning context. Smith and Rothkopf (1984), studied the effects of learning context with field dependent and field independent subjects. Field dependent persons are those who tend to perceive the background or environment that a stimulus is presented in, in addition to the stimulus itself. Field independent persons are those less sensitive to the environment or background than to the stimulus. The room in which the training took place determined the context of the study (same room everyday was constant context, while differing the room each day of instruction was diversified context). The results showed that no matter what context the training was presented in, the performance at the end of each lesson was equivalent. However, after 5 days, the field-dependent group showed higher performance scores. These findings seemed to have been a result of the field dependent subjects' tendency to focus on the environment as well as the stimulus. Smith and Rothkopf (1984) suggest that using only field-dependent subjects may offer a better sample for testing the effects of context and that previous research on context may have been adversely effected by not differentiating on the cognitive variable of field-dependence. In Smith's later work (1985), field-dependent subjects had higher scores in a context-dependent recall memory test than did field-independent subjects. However, this difference was not shown in the tests of recognition memory.

Context and transfer. As discussed, context has also been identified as the presentation of system components within or separate from the system they normally exist. Park, Teague and Gittelman (In Preparation, 1994) taught subjects basic electronic circuit knowledge by presenting the individual gates alone (context-independent) or as part of an entire electronic circuit (context-dependent). Subjects were then tested on troubleshooting problems in similar or dissimilar circuit configurations than they were trained. Results showed that subjects taught about the circuit components alone, separate from the system, performed better on the dissimilar (transfer) problems than did the subjects taught about the circuit components as part of a circuit. The context-dependent subjects, however, performed better on the problems that were similar to the way they were trained. Smith and Rothkopf (1984) stated that learning in the classroom is used in settings different from the classroom environment and as a result, tests and other measures of performance in this "similar" environment can be misleading. They suggest that diversifying the learning environment could lead to improvements in performance in outside or "dissimilar" environments. Thus, it may be beneficial to instruct subjects in a context independent manner if performance is expected to occur in a different environment.

Context and attention. Context may be important since it may influence learning by focusing or distracting subject's attention. Encoding of target information seems to result from attention properly focused with learning a "function of the mental activity of the subjects during encoding" (Del Rey, Wughalter, Du Bois, and Carnes, 1982, p. 467). Norman (1976) said of context, "our interpretation of sensory signals depends on the whole environment in which they are embedded" (p.41). According to Ackerman (1987), learning environment is either context-independent or context-interactive. Independent-context is one in which the context and the target, or stimuli, are separate, both perceptually and conceptually. Context-interactive environments are those in which there is some relation between the target and its context. Perception of the target is the primary

cue for its identification in context-independent environments, while both context and target are combined to create an elaboration of the target in context-interactive environments. These two operationalizations of context were investigated for their effects on selective attention. According to Ackerman (1987), it is important to distinguish between environments that are context-independent and those that are context-interactive since attention to the context within which a target is presented can enhance recall of the target. However, attention to context separate from the target can impair recall if it occurs in a context-independent environment.

Even with the many varied operationalizations of context, the studies have one point in common: context is important since it seems to influence the ability to learn, and must be accounted for in the design of an efficient training system.

Conclusions

It is important to recognize that part-task training and whole-task training can occur in either a context-dependent or context-independent presentation. Trainees can learn about part of the task or the entire task in either an environment similar to or different from the one in which they will be required to demonstrate their knowledge. Regardless of how the training is designed, careful attention must be paid to the strengths and weaknesses of each method.

Research has brought us to a basic understanding of the application of part/whole-task training that depends on the task structure and the individual differences of the trainees. Generally, if a task can be approximated using a whole-task training method, it should be used because of the possible savings in cost and effort required to divide the task into segments and reintegrate the parts as needed in a part-task training method. Even if a particular task can be trained to most persons via a whole-task method, it may not be best for some people. Consideration of individual differences is important, along with the analysis of the task structure, in determining what method of training will be most efficient for training a particular skill.

If the task can't be taught as a whole to an individual because of the complexity of the task or his or her ability, part-task training should be the method of choice. As Knerr, et. al., (1985) reported, part-task training becomes necessary with tasks of high complexity and tasks that may be dangerous or costly to train as a whole. Trainees with mental deficits benefit from part-task training because the cognitive requirement to process only one part at a time is much lower than that for processing the whole task simultaneously. While understanding the learner and the task is important in selecting a training method, division of the task into "natural" parts is most important for planning and developing a part-task training method. The "small wholes" as Holding (1965) termed them, are important for acquisition of the skill. However, the presentation method of the "small wholes" is also important. According to Holding, providing trainees with an overall understanding of the system structure and functions and then presenting the task parts will facilitate learning of the system. When people are trained with a part-task training method, they are likely to see advancement and improvement in their performance since they are only receiving parts of the task at a time.

Training context is often determined by the setting or environment in which a target stimulus is presented. Although research findings concerning the effects of context in training are not always consistent, a general view emerged from research that context-dependent methods are more effective than context-independent methods for teaching words and sentences, reading comprehension, and problem solving skills that will be recalled in the same environment. In contrast, when the knowledge and skills about task components are independent of one another and need to be transferred to a variety of tasks, a context-independent training method is generally better than a context-dependent method. When the knowledge and skills can only be transferred in an integrated form, a context-dependent method is recommended.

As discussed earlier, since a training method should be selected and planned based on various factors, including task characteristics, trainee individual differences and

other situational variables, further research on context-dependency in training should be conducted in order to provide a comprehensive set of recommendations for selecting and designing a context-dependent or independent training method for a given training situation.

As McGeoch (1931) stated, "there is no inherently superior method (for training): the absolute and relative efficiencies of any given method are the complex resultant of the pattern of experimental conditions in which many factors are differently and reciprocally effective." This holds for both part/whole-task training and context-dependent/independent presentation. However, if McGeoch could have seen into the future, she may have agreed that computers can be used to facilitate learning by allowing training developers to present information in a variety of methods. The training presentation can be adapted to address the individual difference variables previously discussed by matching the presentation method with the students' strengths.

In summary, based on the review of the literature, the following guidelines are recommended regarding part/whole training: 1) considerations of the individual differences of trainees, as well as the structure and characteristics of the task are important; 2) if a task can be approximated and understood as a whole, it is generally recommended to train with a whole-task method; 3) if the task is highly complex or dangerous then part-task training is generally recommended; 4) tasks being taught by a part-task method must be broken into "natural" sub-units for effective presentation; and 5) trainees in part-task training methods should be given an idea of the whole system before being presented with the parts. Regarding training context, the following guidelines are suggested: 1) context-dependent methods should be used for teaching words and sentences, reading comprehension, and problem solving skills that will be recalled in the same environment that training occurs; 2) context-independent training methods should generally be used when knowledge and skills about task components are independent of one another and need to be transferred to a variety of tasks; and 3) a

context-dependent method is recommended when the knowledge and skills can only be transferred in an integrated form.

Table 1. Effects of Part-Task Training (PTT) and Whole-Task Training (WTT):
Research Findings

Author(s) & Year	Subjects	Task	Findings
Naylor (1962)	Literature Review	Variety of Part- Whole Tasks	WTT was better for highly organized tasks, as the difficulty increased, while PTT was best for low organized tasks with increasing difficulty.
Anderson (1968)	1st graders	Concept learning problems	PTT was better than WTT retention in a highly organized, difficult task.
Nettlebeck, Kirby (1976)	30 mentally retarded females	Threading of an industrial sewing machine	PTT was more effective than WTT.
Stammers (1980)	72 undergrad students	Dot tracking on a CRT display	WTT was initially more effective than PTT as complexity increased, but this difference was not shown in later learning.
Wightman, Sistrunk (1987)	40 Male students	Carrier landings on a Conventional Takeoff and Landing Simulator	PTT was more effective than WTT.
Ash (1988)	61 musically inexperienced students	Perceptual motor task (learning to play keyboard)	PTT was more effective than WTT.
Mane, Adams, Donchin (1989)	60 males, 18-24	Computer game performance	PTT was more effective than adaptive training methods.

Author(s) & Year	Subjects	Task	Findings
Newell, Carlton, Fisher, Rutter (1989)	96 males, 18-23	Computer game performance	PTT was more effective than WTT.
Mattoon (1992)	41 male and female undergrad students	Location and orientation of target aircraft using a HUD	PTT was more effective than WTT.

Table 2. Effects of Context-Dependent Training (CDT) and Context-Independent Training (CIT): Research Findings

Author(s) & Year	Subjects	Task	Findings
Swede, McNulty (1967)	80 female students 17-23 yrs.	Learning and retention of paired associates	CDT was more effective than CIT.
Rohwer, Schuell, Levin (1967)	208 5th and 6th grade students	Storage and retrieval of noun pairs	Contextual cues were necessary for storage, but not for retrieval.
Tenenbaum (1977)	32 high school students	Comprehension and recall of prose	Contextual organization of material aided recall.
Humphreys (1978)	96 college students	Recognition and retrieval of word pairs	Effects of context were attributable to the item and relational information of the words.
Montgomery, Richman (1979)	3rd grade students	Discrimination problems	Contextual information is important in cognitive processing.
Canelos, Taylor, Altschuld (1982)	60 college students	Recall of instructional program	CIT was more effective than CDT.
Del Rey, Wughalter, Du Bois, Carnes (1982)	54 female graduate students	Coincidence anticipation task	No difference between CDT and CIT.
Hayes, Readence (1983)	7th grade students	Recall and transfer of text passages	CDT (text with illustration) was more effective than CIT.
Smith (1984)	120 college students	Standard recall test	CDT was more effective than CIT.
Smith (1985)	240 college students	Memorization and recall of word lists	No difference between CDT and CIT.
Smith (1986)	36 college students	Short term memory task	Context dependence was more effective.

Author(s) & Year	Subjects	Task	Findings
Spencer, Weisberg (1986)	240 college students	Analogical transfer problem	CDT was more effective for transfer than CIT.
Ackerman (1987)	144 2nd graders 144 6th graders, 144 college adults	Recall of word triplets	CDT (particularly, context interactive situations) facilitated recall, but CIT inhibited recall.
Park, Teague, Gittelman (1994)	96 college students	Electronic troubleshooting	CDT was more effective for transfer to similar situations, while CIT was more effective for transfer to dissimilar situations.

References

- Ackerman, B. P. (1987). Attention of memory in children and adults in context-interactive and context-independent situations. Journal of Experimental Child Psychology, 44, 192-221.
- Anderson, R. L. (1968). Part-task versus whole-task procedures for teaching a problem solving skill to first graders. Journal of Educational Psychology, 59(3), 207-214.
- Ash, D. W. (1988). Part versus whole learning: Task separation and reintegration strategies. UMI Dissertation Services: Ann Arbor, MI.
- Brown, A. L. (1990). Domain-specific principles affect learning and transfer in children. Cognitive Science, 14, 107-133.
- Canelos, J., Taylor, W., & Altschuld, J. (1982). Content independent learning strategies and their relative effectiveness on acquiring concept information and spatial information when learning from visualized instruction. Presented at the Annual Meeting of the Association for Educational Communications and Technology, Research and Theory Division, Dallas, TX. (ERIC Document Reproduction Service No. ED 223 212)
- Cerri, S. A. (1989). ALICE: Acquisition of linguistic items in the context of examples. Instructional Sciences, 18, 63-92.
- Christ, R. E. (1985). Review and analysis of color coding research for visual displays. Human Factors, 17(6), 542-570.
- Crafts, L. W. (1932). Whole and part methods with visual spatial material. American Journal of Psychology, pp. 526-534.
- Del Rey, P., Wughalter, E., Du Bois, D., & Carnes, M. M. (1982). Effects of contextual interference and retention intervals on transfer. Perceptual and Motor Skills, 54, 467-476.
- Eberts, R. E., & Brock, J. F. (1987). Computer-assisted and computer-managed instruction. In G. Salvendy (Ed.), Handbook of Human Factors (pp. 976-1011). New York: John Wiley & Sons.

- Goggin, J., & Stokes, C. (1969). Whole and part learning as a function of approximation to English. Journal of Experimental Psychology, 81, 67-71.
- Goldstein, I. L. (1986). Training in organizations: Needs assessment, development, and evaluation. Pacific Grove, CA: Brooks/Cole Publishing Company.
- Hayes, D. A., & Readence, J. E. (1983). Transfer of learning from illustration-dependent text. Journal of Educational Research, pp. 245-248.
- Holding, D. H. (1965). Principles of training. Oxford: Pergamon.
- Humphreys, M. S. (1978). Item and relational information: A case for context independent retrieval. Journal of Verbal Learning and Verbal Behavior, 17, 175-187.
- Knerr, C. M., Morrison, J. E., Mumaw, R. J., Stein, D. J., Sticha, P. J., Hoffman, R. G., Buede, D. M., & Holding, D. H. (1985). Simulator-based research in part-task training (Report FR-PRD-85-11). Alexandria, VA: Human Resources Research Organization.
- Mane, A. M., Adams, J. A., & Donchin, E. (1989). Adaptive and part-whole training in the acquisition of a complex perceptual-motor skill. Acta Psychologica, 71, 179-196.
- Mattoon, J. S. (1992). Learner control and part/whole-task practice methods in instructional simulation. (ERIC Document Reproduction Service No. ED 346 114)
- McGeoch, G. O. (1931). Whole-part problem. Psychological Bulletin, 28(10), 713-739.
- Memon, A., & Bruce, V. (1985-86). Context effects in episodic studies of verbal and facial memory: A review. Current Psychological Research & Reviews, Winter, 349-369.
- Montgomery, T., & Richman, S. (1979). Effects of meaningfulness and context on information processing in third-graders. Presented at the Annual Convention of the Southeastern Psychological Association, New Orleans, LA. (ERIC Document Reproduction Service No. ED 174 934)
- Morgan, A. L. (1985). Changing perspectives on context. Reading Horizons, 25(2), 111-119. (UMI Article Clearinghouse No. CS730483)

- Naylor, J. C. (1962). Parameters affecting the relative efficiency of part and whole training methods: A review of the literature (Report No. NAVTRADEVCECEN 950-1). Port Washington, NY: U.S. Naval Training Device Center.
- Naylor, J. C., & Briggs, G. E. (1963). Effects of task complexity and task organization on the relative efficiency of part and whole training methods. Journal of Experimental Psychology, 65, 217-224.
- Nettlebeck, T., & Kirby, N. H. (1976). A comparison of part and whole training methods with mildly mentally retarded workers. Journal of Occupational Psychology, 49, 115-120.
- Newell, K. M., Carlton, M. J., Fisher, A. T., & Rutter, B. G. (1989). Whole-part training strategies for learning the response dynamics of microprocessor driven simulators. Acta Psychologica, 71, 197-216.
- Norman, D. A. (1976). An introduction to human information processing (pp. 39-42). New York: Wiley.
- Park, O., Gittelman, S. S., & Wilt, G. A. (1993). Mental models and training strategies in electronic troubleshooting skill acquisition (Unpublished manuscript). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. Submitted as Technical Report.
- Park, O., Teague, R. C., & Gittelman, S. S. (1994). In preparation.
- Reiser, R. A. (1987). Instructional technology: A history. In R. M. Gagne (Ed.), Instructional Technology: Foundations. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Rohwer, W. D., Jr., Shuell, T. J., & Levin, J. R. (1967). Context effects in the initial storage and retrieval of noun pairs. Journal of Verbal Learning and Verbal Behavior, 6, 796-801.
- Smith, S. M. (1984). A comparison of two techniques for reducing context-dependent forgetting. Memory and Cognition, 12(5), 477-482.
- Smith, S. M. (1985). Environmental context and recognition memory reconsidered. Bulletin of the Psychonomic Society, 23(3), 173-176.

- Smith, S. M. (1986). Environmental context-dependent recognition memory using a short-term memory task for input. Memory and Cognition, 14(4), 347-354.
- Smith, S. M., & Rothkopf, E. Z. (1984). Contextual enrichment and distribution of practice in the classroom. Cognition and Memory, 1(3), 341-358.
- Spencer, R. M., & Weisberg, R. W. (1986). Context-dependent effects on analogical transfer. Memory and Cognition, 14(5), 442-449.
- Stammers, R. B. (1980). Part and whole practice for a tracking task: Effects of task variables and amount of practice. Perceptual and Motor Skills, 50, 203-210.
- Swede, G., & McNulty, J. A. (1967). The influence of contextual cues upon the learning and retention of paired associates. Canadian Journal of Psychology, 21(5), 394-408.
- Tenenbaum, A. B. (1977). Task-dependent effects of organization and context upon comprehension of prose. Journal of Educational Psychology, 69(8), 528-536.
- Tulving, E., & Pearlstone, Z. (1966). Availability versus accessibility of information in memory for words. Journal of Verbal Learning and Verbal Behavior, 5, 381-391.
- Watkins, O. C., & Watkins, M. J. (1975). Buildup of proactive inhibition as a cue-overload effect. Journal of Experimental Psychology: Human Learning and Memory, 104, 442-452.
- Wightman, D. C., & Sistrunk, F. (1987). Part-task training strategies in simulated carrier landing final-approach training. Human Factors, 29(3), 245-254.