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Influences of Training and Strategical Information Processing Style on Spatial Performance in Apparel Design

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Abstract

The study investigated how performance on a spatial task in apparel design was influenced by training and strategical information processing style. The sample consisted of 278 undergraduate apparel design students from six universities in the U.S. Instruments used to collect data were the Apparel Spatial Visualization Test (ASVT) and the Strategical Information Processing Style (SIPS). ANOVA results showed a significant difference in performance on the ASVT between students with more training and those with less training in apparel design. There was no significant difference in performance on the ASVT as a result of students' preferred strategical information processing styles. Findings of the study indicated that performance on a spatial visualization task was influenced by training but not by strategical information processing style.

Introduction

One of the cognitive components required for individuals aspiring to careers in apparel design is spatial visualization. The ability to visualize spatially has been established as a predictor of success in several technical career fields like apparel design (Strong & Smith, 2002).

Apparel design is one career where spatial skills are crucial. The core of apparel design is creation of ideas for new styles; therefore, it is important for designers to communicate design ideas. Communication of design ideas requires spatial visualization because ideas are intangible (Workman & Zhang, 1999). Trade sketches, patterns, and fashion illustrations are basic forms of communication in the apparel industry. For example, patterns are used to communicate technical details to designers and technicians. These basic forms of communication involve spatial visualization skills.

In apparel design, visual thinking is needed to understand patterns, to analyze styles and to interpret charts, graphs, or tables because words alone cannot convey the visual concepts involved (Workman & Lee, 2004). As individuals learn pattern-making skills, they also develop the ability to observe a three-dimensional form (i.e., a garment) and accurately translate it into two-dimensional shapes (i.e., the pattern pieces necessary to create the style). This translation facilitates creation of pattern silhouettes that "come to life" when constructed into three- dimensional garments.

Research has shown that training can lead to improvement in spatial visualization ability (Mack, 1994). Presumably, an apparel design curriculum includes training in spatial visualization aspects that are required to perform well on a spatial visualization task. The challenge for apparel design instructors and researchers over the years has been to identify and measure specific spatial abilities needed by apparel design students so as to better prepare them for a design career. There are hundreds of tests available to measure a variety of spatial abilities (McGee, 1979). One limitation of these tests is that they measure general spatial abilities (Workman, Caldwell, & Kallal, 1999). This limitation led to the development of a spatial visualization test by Workman, Caldwell and Kallal, that measured spatial abilities associated with apparel design and product development, the Apparel Spatial Visualization Test (ASVT).

In order to plan curricula to help students develop skills appropriate to their chosen career, educators and researchers must be aware of individual differences in students' preferred method of using their cognitive abilities, that is, their preferred strategical information processing styles. How well a student uses his or her cognitive ability seems to depend on his or her preferred method of processing information (Farrell, 2001). Farrell found no relationship between strategical information processing styles (visual-spatial, analytical, social and categorical) and college major or credit hours and concluded that the constructs were unrelated to training. According to Farrell (2001), strategical information processing styles are probably not trainable but are related to personality attributes of an individual. Research is needed to investigate links between a student's strategical information processing style and his or her cognitive abilities (Farrell & Kotrlik, 2003).

Objective of Study

The purpose of this study was to contribute to a better understanding of individual differences in processing of spatial information. The study focused on how performance on a spatial task was influenced by training and strategical information processing styles. Understanding influences on spatial visualization will enable instructors in technical fields to identify methods to help students develop spatial skills.

The following research questions guided the study: How is performance on a spatial visualization task influenced by training? How is performance on a spatial visualization task influenced by preferred strategical information processing style? How does training influence preferred strategical information processing style?

Importance of Spatial Visualization

Spatial visualization ability has been shown to be a vital part of individuals' success in a wide range of cognitively demanding educational tracks, occupations, and professions. For example, spatial visualization ability is vital to careers in architecture, art, cartography, chemistry, drafting, engineering, mathematics, medical surgery, physics, and surveying (Miller & Bertoline, 1991; Strong & Smith, 2002). Humphreys, Lubinski, and Yao (1993) contended that spatial skills are also vital to success in occupations involving the creative arts. These authors challenged the prevailing emphasis on verbal and numeric skills of national achievement tests and supported inclusion of spatial skills testing for college entry-level tests. Humphreys et al. believed more spatially talented students could be entering technical disciplines which correspond to their abilities and interests. Although spatial tests have tended to be restricted to testing for suitability for occupations below the professional level, Humphreys et al. suggested that spatial tests should be used in selection of candidates for high-level technical disciplines at the professional level. Career counselors should be aware of the relevance of spatial abilities when advising students in the creative arts (Humphreys et al., 1993).

The neglect of spatial abilities may stem from false beliefs that spatial ability is more relevant to technical trades while academic or professional endeavors require verbal and numeric competencies. Identifying students with exceptional spatial abilities is an important societal function that can lead to great innovations (Smith, 1964). If the educational system is to fulfill its obligation to students and society, spatial visualization ability needs to be nurtured because it is a crucial feature of the human cognitive repertoire (Shea, Lubinski, & Benbow, 2001).

Spatial visualization ability is important in terms of navigation within the realm of computers and computer applications such as computer-aided apparel design. It is also a significant factor in predicting human/computer interaction (Strong & Smith, 2002). Despite the centrality of spatial aptitude to an understanding of human behavior, little is known about the underlying cognitive processes that contribute to spatial ability or about the nature and locus of individual differences in spatial skill (Cooper & Mumaw, 1985). According to Strong and Smith (2002), several factors including age, gender, individual aptitude differences, and experience impact spatial visualization ability. Of these factors, experience of sufficient length and type improves spatial visualization and may compensate for deficiencies caused by age, gender, or lack of relevant previous experience.

Training of Spatial Visualization

Attempts to improve spatial ability by providing training have met with conflicting results (Baker, 1990; Kyllonen, Lohman & Snow, 1984). Mumaw and Pellegrino (1984) studied individual differences in complex spatial processing using a “hardware” versus “software” approach. They suggested that high ability subjects have a memory that allows them to construct representations and preserve more information over time, implying differences in cognitive hardware. The possibility that high ability subjects are simply more efficient in application of better strategies, thus extracting important information when encoding stimuli as a result of knowledge differences depends on a software explanation. The software approach has implications for training.

Drauden (1980) found that although spatial scores could be improved through training, it was difficult to consistently obtain improvement without an efficient training method. Drauden outlined attributes that are desirable for the form and content of a spatial training program. The training should make use of concrete materials and be gradual, from easy to more complex materials. Materials used should require subject participation and responses. Subjects should receive immediate feedback on their responses and have frequent experiences of success.

Individual differences in trainability have been found whereby individuals who are high in spatial ability do not always benefit from instruction (Kyllonen et al., 1984). Individuals with different levels of spatial ability appeared to use different strategies and to be affected differently by treatments that attempted to train the different strategies. The effect of training depended substantially on the aptitude profile of the learner. Strategic training for spatial aptitude task performance appeared beneficial to some extent. Long-term effects of training interventions may be quite different from short-term. Some individuals may show temporary decrement due to interference with established strategies. Continued practice with a different strategy may ultimately lead to substantial improvement in performance (Kyllonen, Lohman, & Snow, 1984).

Frandsen and Holder (1969) investigated differences in internal and external factors that cause individuals to vary in their effectiveness in solving complex problems. Examples of internal factors were amount of stored information and retention of concepts, while external factors included cues in problem solutions and instructions which guided the learner. Frandsen and Holder investigated whether external factors such as efficient instruction could compensate for a deficiency in an internal factor such as spatial visualization. The study showed that spatial visualization aptitude could be compensated for by instruction.

Whether specific course content can improve spatial visualization ability of college students is a question of interest. Lajoie (1986) commented that “It is likely that spatial abilities remain in the implicit rather than the explicit curriculum since the real world applications of spatial abilities are not apparent to many educators. Perhaps few teachers have highly developed spatial ability and thus they have difficulty using or teaching such skills” (p. 36).

Training of Spatial Visualization in Apparel Design

The educational system in the U.S. does not emphasize visual skill development (Roth, 1993), for example, high school offerings in art and apparel construction are limited. Thus college freshmen in an apparel design major often lack experience and ability to comprehend how three-dimensional garments are formed from two-dimensional garment parts (Orzada & Kallal, 2001).

Training students on how to interpret visual cues in a specific domain is part of many university curriculums. An apparel design curriculum is based on a foundation of domain specific knowledge that is used to solve complex problems in apparel design. Students cannot be exposed to every single design feature due to the continually changing nature of fashion. Hence, it is critical to teach students effective problem-solving skills (Workman & Lee, 2004).

Curricula in university programs that train apparel designers include courses in draping, sewing, fabrics and trimmings, drawing, pattern-making, principles of design, production and costing of items (Dolber, 1989). Many of these courses are designed to improve students' ability to draw and read graphic language. For example, the ability to recognize, read, and understand the graphic language of patterns, including their shape, sizes, curves, proportions, grain lines, symbols, labels, perforations and notches, are important skills incorporated in the fashion design curriculum. Spatial visualization skills required in the clothing construction process include mental synthesis and mental movement, for example, reflecting, rotating, reversing polarity, dimensionality crossing, folding/unfolding, and moving (Workman & Caldwell, in press). Some examples of procedures involving spatial visualization are folding and unfolding pattern pieces, reflecting sleeves, and matching edges. Beginning pattern makers often have difficulty visualizing the three-dimensional form of an apparel design from a flat pattern; however, their skills improve with practice (Armstrong, 1995). To prepare successful designers, educators must know what types of exercises will improve students' visualization skills.

Workman and Caldwell (in press) examined the effects of indirect training provided by apparel design and product development courses on spatial visualization skills. The Apparel Spatial Visualization Test was used to measure domain-specific spatial visualization skills in apparel design while the Paper Folding Test was used as a measure of general spatial visualization ability. Results showed improvement in scores on both tests at posttest compared with pretest. Workman and Caldwell concluded that indirect training provided in apparel design and product development classes lead to improvement in students' scores on tests measuring both general and domain-specific spatial visualization.

What strategies individuals use to solve items on spatial tasks such as the Apparel Spatial Visualization Test or Paper Folding Test is unclear. Individual differences in strategy use have implications for testing and training spatial ability.

The study of strategies individuals use to solve spatial tasks can enrich basic research on spatial cognition.

Spatial Visualization and Strategy Use

A strategy has been defined as one of several alternative methods for performing a particular cognitive task (Saczynski, Willis, & Schaie, 2002). Information processing is an active process that involves the use of strategies (Forrest, 2001). A strategy is an individual's approach to a task. It is the way an individual organizes the many sensory-motor systems for meaning. Because more than one possible strategy is available to solve a problem or do a task, which one is selected and used depends on a choice made by an individual. This decision is not consciously determined and may depend on many internal and external factors, including past experience. Though there are many information-processing strategies possible, two that appear most fundamental are pictorial and linguistic strategies. The linguistic strategy represents the use of internal and external verbal language. The pictorial strategy represents the use of visual imagery and is spatial.

Collins (1988) described individuals employing a holistic or simultaneous strategy as having an ease of manipulation due to the ability to treat all available information as a unitary whole. Individuals employing an analytical strategy were described as being able to internally represent spatial information in terms of its various characteristics one by one, dependent on words more than pictures. According to Gluck and Fitting (2003), materials and instruction for tests of spatial ability have been designed to evoke holistic rather than analytic strategies. Individuals who have a preference for analytic strategies may be disadvantaged in such tests.

Michaelides (2002) studied solution strategies in spatial rotational tasks by testing 107 fifth to eighth grade students on spatial rotation multiple-choice items. Thirty-one of them were interviewed and asked to explain their reasoning when solving four of the test items. Results showed that students did not make consistent use of only one type of strategy across tasks. Task characteristics may have influenced the choice of strategy in each case. Students switched between visual and non-visual strategies or combined both. According to Michaelides, the frequent occurrence of combined strategies could be attributed to the question format. The multiple-choice format encouraged attempts to confirm one answer, by eliminating the rest of the choices. Such a comparison could mobilize the use of analytic thinking to locate differences in the picture in a systematic and orderly manner rather than grasping a representation immediately as a whole.

Strategical Information Processing Styles

"One's preferred approach to information processing can be referred to as one's cognitive style" (Hayes & Allison, 1998, p. 847). Cognitive styles can be divided into three categories: learning styles, cognitive strategies and cognitive abilities (Smith & Ragan, 1999). Learning styles are defined as the methods consistently employed by individuals to interact with the learning environment. Cognitive strategies are the procedures employed by learners to expedite knowledge gain. Cognitive abilities involve the application of mastered content knowledge to performance (Hayes & Allison, 1998).

Orzada and Kallal (2001) reasoned that spatial visualization is an important skill for apparel designers; and therefore, design students may have a preference for processing visual versus verbal information. These authors collected data from students in apparel design and merchandising classes using the Apparel Spatial Visualization Test (Workman, Caldwell, & Kallal, 1999) and the Style of Processing scale (Childers, Houston, & Heckler, 1985) which measures preferences for processing either visual or verbal information. Results showed a significant correlation between the Apparel Spatial Visualization Test and the visual component of the Style of Processing scale ($r = .24$, $p < .01$).

Khoza (2003) used the Perceptual Modality Preference Survey (Cherry, 1981) to identify fashion design and merchandising students' personal preferences for learning via print, aural, interactive, visual, haptic, kinesthetic, or olfactory perceptual learning styles. Khoza hypothesized that there would be a relationship between preferred learning style and performance on a spatial task (as measured by the Apparel Spatial Visualization Test). There was no significant correlation between preferred perceptual modality and scores on the Apparel Spatial Visualization Test. Further, preferred perceptual modality did not vary as a result of training, that is, students in lower level and upper level courses did not differ in their perceptual modality preferences.

According to information processing system theory, individuals receive and process information for memory encoding, rehearsal, storage, and retrieval. The theory includes the senses, sensory registers, short term/working memory, and long term memory. Information that is received through the senses and not discarded enters the sensory registers. Sensory registers act as information receptors or collection bins. From the sensory registers, information travels to working memory although some of it is lost. Information that receives attention and is meaningful is encoded for storage in long term memory. Long term memory has unlimited capacity and information is never lost. However, accessibility to the information is lost over time. Accessible information in long term memory can be retrieved into working memory for processing (Baddeley, 2002; Craik & Lockhart, 1972; Parker, 1993).

The Strategical Information Processing Styles (SIPS) instrument was designed based on information processing systems theory (Farrell, 2001). The SIPS instrument provides a measure of the strategies that individuals prefer to employ when processing information. Empirical evidence has verified four strategical information processing styles: (a) visual-spatial, (b) analytical, (c) social, and (d) categorical (Farrell, 2001). Visual-spatial processors selectively attend to the characteristics of stimuli that involve imagery. Spatial tasks sustain the attention of the visual-spatial processors enabling them to arrive at accurate solutions. Analytical processors selectively attend to stimuli that are presented in a logical order. When a task makes sense and requires logical thinking, it sustains the attention of analytical processors. They are serial processors who encode information in a logical step-by-step fashion. Social processors selectively attend to stimuli that involve relationships and emotions. Group and social tasks sustain their attention. They have the ability to express their own perceptions of a situation through emotions. Categorical processors selectively attend to the detailed characteristics of either visual or verbal stimuli. They attend to tasks that require detailed, organized strategies.

According to Farrell and Kotrlik (2003), perhaps a student’s strategical information processing style could provide a link between general intelligence and cognitive abilities. Awareness of a student’s style would enable educators to design educational experiences that tapped into the student’s cognitive resources.

Method

Participants

Participants in the study were students enrolled in apparel design classes in U.S. universities. Universities were considered for the study if they offered apparel design classes as indicated in the International Textile and Apparel Association (ITAA) 2004 Membership Directory. The researchers used professional contacts with professors and good reputation of the apparel design programs to select institutions to be included in the study. There was an effort to include universities from different geographic regions in the U.S.

Participants were 278 students from six universities (267 females; 11 males; mean age = 20.58). Most students were majoring in fashion design (n = 276). Participants' racial/ethnic background was: 218 Caucasian, 17 African American, 15 Asian, 10 Hispanic, 2 Native American, and 16 with missing data.

Materials

Three instruments were used to collect data: Apparel Spatial Visualization Test (ASVT), Strategical Information Processing Style (SIPS) instrument, and a demographic questionnaire.

The ASVT "measures apparel spatial visualization ability and requires mentally folding and unfolding, matching, and combining pattern pieces to form a complete pattern, and mentally transforming multiple two-dimensional pattern pieces into a three-dimensional garment" (Workman & Zhang, 1999, p. 172). Choosing the correct solution to items on the ASVT requires 2-dimensional to 3-dimensional transformations. The ASVT consists of 20 sets of flat, 2-dimensional pattern pieces accompanied by front view sketches of five 3-dimensional garments. Participants are asked to choose which one of the garments could be made from the set of pattern pieces. The content validity of the ASVT has been established in previous studies (Workman, Caldwell, & Kallal, 1999; Workman & Lee, 2004; Workman & Zhang, 1999). The ASVT correlated significantly with the Surface Development Test (r = .65, $p < .001$) and the Paper Folding Test (r = .38, $p < .001$) indicating the tests measure a similar construct, that is, spatial visualization. ASVT content validity is also confirmed by test scores reflecting improvement as a function of training in apparel design courses (Orzada & Kallal, 2001; Workman, Caldwell, & Kallal, 1999; Workman & Lee, 2004; Workman & Zhang, 1999).

The SIPS instrument was designed to furnish educators with a high-quality, easily administered, self-assessment tool to determine students' strategical information processing style. Empirical evidence verified four strategical information processing styles: visual-spatial, analytical, social, and categorical (Farrell, 2001). The SIPS instrument has acceptable convergent and discriminate validities. Composite reliabilities for the factors were: visual-spatial .72; analytical .73; social .75; and categorical .78. The SIPS instrument contains 13 situations. For each item, five strategies were provided. Participants respond to each situation by indicating their level of preference for each strategy using a 5-point scale (5 = most prefer, 4 = more often prefer, 3 = prefer, 2 = seldom prefer, and 1 = least prefer). Participants rank each situation for each of the five strategies and can use each preference more than once per question. An example item is "When studying for a written exam in one of my courses, I…. (a) Become overwhelmed if there is too much to learn. (b) Outline the information. (c) Put information into categories. (d) Relate my experiences to the new information. (e) Use pictures and images to clarify the information."

The demographic questionnaire collected information about gender, age, major, and ethnicity as well as training in apparel design. Training was measured in three ways: year in school, basic (no prerequisite) or advanced (prerequisite) level of class in which questionnaire was completed and number of credit hours completed in apparel design courses.

The researcher studied each university's website and undergraduate catalogue in order to list the apparel design courses taught in that institution and the credit hours for each course. Each university had a different listing of courses in the demographic questionnaire. The purpose of using course titles specific to each university catalogue was to use course titles that were familiar to each student sample. In addition, use of familiar terms in the course titles enabled the students to recall the courses they had completed. Students checked the courses they had completed and the researcher used this information to calculate the number of credit hours a student had taken in apparel design courses.

An example of one of the classes in the apparel design curriculum is beginning clothing construction which has no prerequisite. In the course, students learn beginning skills in fitting, construction, and pattern and fabric usage. Course objectives include developing competency in basic sewing skills and production principles. Generally, the beginning class is followed by one or more higher level classes in clothing construction which concentrate on increasingly more complex skills in fitting, construction and fabric usage.

Advanced fashion design classes such as flat patternmaking, draping, and computer-aided apparel design, depend on skills learned in lower level classes. In pattenmaking classes, students draft, drape, and fit basic patterns; make patterns for various styles through flat pattern manipulation, drafting, or draping; test patterns by cutting and constructing the styles in muslin; then refine the patterns to adjust the fit. Course objectives include development of an understanding of the principles used in designing using flat pattern, drafting, and draping methods and developing an ability to create original designs. Computer Aided Design (CAD) courses provide basic skills related to technical flat sketching; pattern drafting, grading and marking; fashion illustration; and textile design.

Procedure

Human subjects' approval was secured from the university. The researcher used previous professional contacts with professors and good reputation of apparel design programs to select a sample of 10 institutions. One or two professors from each university were contacted via email to inquire as to whether they would be willing to administer the questionnaires in their classes. The professors informed the researcher via email of their willingness to participate and estimated the number of students who would be enrolled in their classes. Data were collected in September, 2005. Of the six universities used for the final sample, one was in the Southwest, two were on the East coast, two in the Midwest and one on the West coast.

The appropriate number of surveys was mailed to each institution. For ease in returning the surveys, a self-addressed envelope with the correct amount of postage was included. During usual class sessions, students from the various universities were provided with the ASTV, SIPS and the demographic questionnaire. Participants were informed of the purpose of the study, their voluntary participation, approval of the Human Subjects Committee and confidentiality in terms of their individual results. The survey was completed in the following order: demographics, ASVT and SIPS.

Pilot study

The purpose of the pilot study was to test the procedure for sending and administering the questionnaires and to assess whether students understood the instructions on the instruments. Questionnaires were mailed in summer 2005 to one university in the southwestern part of the U.S. (not part of the final sample). Twelve students completed the questionnaire. Results showed the procedure was appropriate and the instructions were clear.

Analysis

Descriptive statistics were used to report demographic information. Reliability and correlation were calculated for the ASVT and the SIPS instruments. ANOVA was used to examine the research questions followed by Student-Newman-Keuls (SNK) post hoc test to examine differences between groups. An alpha level of 0.05 was used for all statistical tests.

Results

The total number of instruments collected from the sample was 312. However, 34 of the instruments were incomplete and were not used for analysis. The final sample consisted of 278 undergraduate students.

Participants' training in apparel design

Participants were comprised of 51 freshmen, 77 sophomores, 76 juniors and 74 seniors. Eighty-five students were in basic courses (i.e., no prerequisite) and 193 were in advanced classes (i.e., prerequisite required). The number of credit hours students had completed in apparel design courses ranged from 0-41. Dividing the students into four groups based on credit hours yielded the following breakdown: Group 1 (n = 73; 0 credit hours completed); Group 2 (n = 84; 1-6 credit hours completed); Group 3 (n = 66; 7-16 credit hours completed); and Group 4 (n = 55; 17 or more credit hours completed).

Reliability and correlation of instruments

The ASVT showed a moderate reliability (r = .77). Overall, the Strategical Information Processing Style instrument showed a low moderate reliability (r = .51). Three of the four processing styles showed moderate reliabilities: Analytical (r = .69); Social (r = .76); and Categorical (r = .70) while the Visual-Spatial (r = .56) style showed a low moderate reliability. Scores on ASVT and SIPS were not significantly correlated with one another (Pearson r correlation) (ASVT/Spatial = -.045; ASVT/Analytical = -.054; ASVT/Social = -.078; ASVT/Categorical = -.063).

Research question 1

How is performance on a spatial visualization task influenced by training? There was a statistically significant difference in performance on a spatial visualization task between students with more training and those with less training in apparel design (see Table 1). Whether the training was measured as year in school, advanced and basic, or the number of credit hours, students with more training scored higher on the ASVT than those with less training in apparel design.

Table 1.
ANOVA of Performance on Spatial Task (ASVT) by Training

Training	Mean score	SD	Mean Square	F	p<
Year in School					
Freshman (n = 51)	10.92	3.70	169.08	12.78	.000
Sophomore (n = 77)	11.26	3.53			
Junior (n = 76)	11.86	4.24			
Senior (n = 74)	14.36*	2.96			
Training level					
Basic (n = 85)	10.62	3.94	304.21	21.91	.000
(No prerequisite)					
Advanced (n = 193)	12.90	3.62			
(Prerequisite)					
Credit Hours					
Group 1	10.70	4.08	236.32	18.91	.000
(0 credit hours; n = 73)					
Group 2	11.05	4.04			
(1-6 credit hours; n = 84)					
Group 3	13.08[#]	3.01			
(7-16 credit hours; n = 66)					
Group 4	14.84[+]	2.28			
(> 16 credit hours; n = 55)					

* The senior group differed significantly from all other groups, SNK p<0.05

[#] Group 3 differed significantly from all other groups, SNK p<0.05.

[+] Group 4 differed significantly from all other groups, SNK p <0.05

Research question 2

How is performance on a spatial visualization task influenced by preferred strategical information processing style? Because of the nature of the scoring of the SIPS instrument, comparisons between groups with different strategical information processing styles could not be made. Each student received a score on each strategical processing style; therefore, comparisons were made between students who preferred or did not prefer each style. There was no statistically significant difference in performance on the ASVT between students who preferred any of the strategical information processing styles and those who did not prefer that style (see Table 2).

Table 2.

ANOVA of Performance on Spatial Task (ASVT) by Preferred Strategical Information Processing Style (SIPS), n=278

	n	Mean Score	SD	Mean Square	F	p<
Visual-Spatial						
Not Prefer	112	12.36	3.75	5.43	.363	.547
Prefer	166	12.07	3.94			
Analytical						
Not Prefer	45	12.82	3.76	21.66	1.45	.229
Prefer	233	12.06	3.88			
Social						
Not Prefer	230	12.37	3.82	46.51	3.14	.077
Prefer	48	11.29	3.96			
Categorical						
Not Prefer	109	12.70	3.85	48.37	3.27	.072
Prefer	169	11.85	3.84			

Research question 3

How does training influence preferred strategical information processing style? ANOVA analysis showed no statistically significant difference in preferred strategical information processing style by training, whether training was considered by year in school, basic or advanced, or by credit hours.

Table 3

ANOVA of Strategical Information Processing Style (SIPS) by Training (Year in School)

SIPS	Year in School	n	Mean	SD	Mean Square	F	p<
Visual-Spatial							
	Freshmen	51	3.19	.91	.338	.452	.716
	Sophomore	77	3.02	.82			
	Juniors	76	3.13	.90			
	Seniors	74	3.07	.83			
Analytical							
	Freshmen	51	3.73	.84	.673	1.133	.336
	Sophomore	77	3.82	.71			
	Juniors	76	3.60	.80			
	Seniors	74	3.68	.75			
Social							
	Freshmen	51	1.93	.79	.393	.489	.690
	Sophomore	77	2.12	.93			
	Juniors	76	2.05	.93			
	Seniors	74	2.09	.89			
Categorical							
	Freshmen	51	2.96	.87	.447	.598	.617
	Sophomore	77	3.16	.88			
	Juniors	76	3.07	.91			
	Seniors	74	3.09	.80			

Table 4.

ANOVA of Strategical Information Processing Style (SIPS) by Training (Basic and Advanced)

SIPS	Training Level	Mean	SD	Mean Square	F	p<
Visual-Spatial						
	Basic (n=85)	3.03	.83	2.253	3.042	.082
	Advanced (n=193)	3.22	.92			
Analytical						
	Basic (n=85)	3.70	.75	.035	.059	.808
	Advanced (n=193)	3.72	.82			
Social						
	Basic (n=85)	2.08	.93	.386	.484	.487
	Advanced (n=193)	2.00	.81			
Categorical						
	Basic (n=85)	3.13	.85	1.901	2.561	.111
	Advanced (n=193)	2.95	.90			

Table 5.

ANOVA of Strategical Information Processing Style (SIPS) by Training (Number of Credit Hours)

SIPS	Credit Hours	Mean	SD	Mean Square	F	p<
Visual-Spatial						
	Group 1	3.27	.90	1.450	1.971	.119
	Group 2	2.97	.86			
	Group 3	3.01	.86			
	Group 4	3.16	.80			
Analytical						
	Group 1	3.74	.79	.430	.720	.541
	Group 2	3.77	.74			
	Group 3	3.59	.80			
	Group 4	3.72	.76			
Social						
	Group 1	1.99	.80	.788	.985	.400
	Group 2	2.19	.98			
	Group 3	2.05	.88			
	Group 4	1.97	.89			
Categorical						
	Group 1	2.95	.88	.737	.990	.398
	Group 2	3.17	.90			
	Group 3	3.06	.86			
	Group 4	3.14	.78			

Group 1 = 0 credit hours completed; n = 73

Group 2 = 1 to 6 credit hours completed; n = 84

Group 3 = 7 to 16 credit hours completed; n = 66

Group 4 = 17 or more credit hours completed; n = 55

Results showed that performance on the ASVT was influenced by training. However, there was no indication that performance on the ASVT was influenced by strategical information processing style. Strategical information processing style preferences were not influenced by training as measured by year in school, basic versus advanced classes, or number of credit hours.

Discussion

Influence of training on ASVT performance

Results of the ANOVA showed a statistically significant difference in performance on a spatial visualization task between students with more training and those with less training in apparel design. Whether the training was measured as year in school, advanced and basic, or the number of credit hours, students with more training scored higher on the ASVT than those with less training in apparel design.

This evidence supports research findings indicating that training in apparel design adds to knowledge that is imperative to the apparel spatial visualization component of the cognitive domain (Khoza, 2003). Training students on how to interpret visual cues in a specific domain is part of many university curriculums. An apparel design curriculum is based on a foundation of domain specific knowledge that is used to solve complex problems in apparel design (Workman & Lee, 2004). Apparel design programs include courses designed to improve students' ability to draw and read graphic language (Workman & Zhang, 2004).

In support of the results that students with less training in apparel design had less spatial visualization skill, Orzada and Kallal (2001) alleged that college freshmen in an apparel design major often lack experience and ability to comprehend how three-dimensional garments are formed from two-dimensional garment parts, however, their skills improve with practice. Research has shown that students enrolled in advanced level apparel design classes score higher on a spatial visualization task than those in lower level courses (Orzada & Kallal, 2001; Workman & Caldwell, in press; Workman, Caldwell & Kallal, 1999; Workman & Lee, 2004; Workman & Zhang, 1999).

Results were consistent with Workman and Caldwell (in press), who examined the effects of indirect training provided by apparel design and product development courses on spatial visualization skills. These authors concluded that indirect training provided in apparel design and product development classes improved students' scores on tests measuring both general and domain-specific spatial visualization. Academic experiences are important predictors of spatial visualization skills (Baker, 1990). Academic experience can be enhanced by including spatially enriching experiences for students.

Influence of strategical information processing style on ASVT performance.

Results showed that performance on the ASVT was not influenced by preferred strategical information processing styles as measured by SIPS. The SIPS instrument has four constructs (visual–spatial, analytical, social and categorical). It was assumed the visual-spatial aspect of the SIPS would be related to the spatial visualization construct of the ASVT. However, students who preferred the visual-spatial processing style did not differ in scores on the ASVT from students who did not prefer the visual-spatial style. Farrell (2001) acknowledged that the visual-spatial indicator variable of the SIP instrument is weak and needs to be strengthened. In this study, the visual-spatial variable of the SIPS instrument had the lowest reliability among the four SIPS variables.

The findings from the current study are similar to Khoza (2003) who used the Perceptual Modality Preference Survey and found that scores on the ASVT were unrelated to preference for perceptual modality. However, Orzada and Kallal (2001) used the Style of Processing scale and found a positive relationship between scores on the ASVT and preference for the visual (versus verbal) style of processing.

According to Thompson, Mann and Harris (1981), males' spatial task performance was related to cognitive style but females' was not. Because 96% of the participants in this study were women, this may help explain why there was no significant influence of SIPS on spatial task performance.

Influence of training on strategical information processing styles.

ANOVA analysis showed no statistically significant difference in preferred strategical information processing style by training, whether training was considered by year in school, basic or advanced, or by credit hours. Results are consistent with Hayes and Allison (1998) who argued that while cognitive style may produce consistent behavior across a wide variety of situations, strategies are specific and essentially represent the result of decisions individuals make to cope with immediate cognitive tasks.

Farrell (2001) found no relationship between the SIPS constructs (visual-spatial, analytical, social and categorical) and college major or credit hours. Farrell concluded that the SIPS constructs were unrelated to training but have to do more with personality attributes of an individual.

Pearson *r* correlation results indicated that there was a very low nonsignificant correlation between the ASVT and SIPS. Preference for strategical information processing style was not related to scores on the ASVT. Since performance on the ASVT was significantly influenced by training, it is logical to conclude that ASVT performance would not be influenced by SIPS which was not influenced by training. This result disputes Farrell and Kotrlik's (2003) assumption that a learner's cognitive ability seems to depend on his or her preferred method of processing information. The cognitive ability measured by the ASVT does not seem to depend on strategical information processing styles.

Although the results of this study may be contextually bound and thus have limited generalization, performance on a spatial task was noticeably influenced by training. Results of this study indicated that strategical information processing style did not influence performance on a spatial task and that strategical information processing style was not influenced by training.

Implications for instruction and curriculum

Students need spatial skills in order to execute the apparel design process. The apparel design process includes identifying a problem, developing preliminary design solutions, refining the solutions, developing a prototype, evaluating the prototype, and finally implementing the solution (Lamb & Kallal, 1992). Each step in the apparel design process lends itself to instruction aimed at developing spatial skills. Although training students how to interpret spatial cues in apparel is already a vital part of apparel design courses, training could be designed to more specifically address each step in the design process. One instructional component that may complement traditional projects is development of exercises that will clarify when and how to use specific strategies such as matching, elimination of alternatives, stimulus analysis, checking and extraction of landmarks.

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