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Our study investigates the construct and predictive validity of a learning styles inventory with a sample of 2,259 military personnel who were participating in job-related training. Results provide construct validity evidence and very limited predictive validity evidence. Implications for future research and practice are discussed.

Training is an incredibly important function in both private sector firms and government organizations. U.S. organizations spend approximately $51.4 billion training their employees (Dolezalek, 2004). The U.S. government's estimated training budget for 2005 was $5.24 billion (GPO Access, 2004). Recently there has been an increased interest in foreign language proficiency and training, in both military (e.g., U.S. Department of Defense [DoD], 2005, 2006) and business settings (Lynch, 2006). Noe (2005) indicates that approximately 20 to 30 percent of organizations have a budget allocated for foreign language training. The large amount of time and money that is invested in employee foreign language training is a reflection of the importance placed on this type of training. In order to ensure that these resources are effective, it is important to identify variables that contribute to foreign language learning or predict foreign language training outcomes, such as speaking proficiency. Once identified, these variables can be used to modify the training environment in order to maximize trainee learning (e.g., providing additional training for the instructor or customized learning strategies for students). The learning style of the student is one concept that is often measured and used for pre-training feedback in foreign language instruction. However, although frequently used, little empirical psychometric evidence exists with regard to learning styles instruments, especially evidence of the link between learning styles and training outcomes. Therefore, our research evaluates the construct and predictive validity of a learning styles

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instrument used in an applied foreign language training setting.

Training Effectiveness

Whereas training evaluation focuses on whether or not training achieved its objectives, training effectiveness focuses on questions designed to improve the training, such as *for whom* was the training effective and *why*. Training effectiveness encompasses many variables, including trainee characteristics, training characteristics, contextual factors, and training criteria (Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995). The interaction between the characteristics of the trainee and the training situation can be used to address important questions about the effectiveness of the training program. Over a decade ago, Tannenbaum and Yukl (1992) indicated the need for more research relating individual differences to training effectiveness. Since then, research investigating the role of individual characteristics in training performance has increased dramatically (e.g., Colquitt, LePine, & Noe, 2000; Facteau, Dobbins, Russell, Ladd, & Kudisch, 1995; Martocchio & Judge, 1997) with many positive implications for practice, as well as substantial theoretical contributions to understanding the training process (Salas & Canon-Bowers, 2001).

Noe and Colquitt (2002) suggested a number of individual differences or trainee characteristics that might be expected to impact training outcomes, such as cognitive ability, basic skills, motivation, and personality. Researchers have frequently examined the influence of cognitive ability on training effectiveness (e.g., Fox, Taylor, & Caylor, 1969; Neel & Dunn, 1959; Tubiana & Ben-Shakbar, 1982; Bell & Kozlowski, 2002; Cannon-Bowers et al., 1995; Olea & Ree, 1994; Ree & Earles, 1991). For example, Cannon-Bowers et al. (1995) found that cognitive ability was strongly and positively related to academic training performance. Whereas cognitive ability has been the most widely researched trainee characteristic, other individual differences that affect training outcomes, such as personality (e.g., Martoccho & Judge, 1997), have been studied less frequently.

The original call for research by Tannenbaum and Yukl (1992) is still relevant today – more research is needed to identify which individual differences are most important in various training situations. Studying individual characteristics and their relationship to training outcomes should result in more effective selection or assignment of trainees, optimized instructional design, and learner-centered strategies to improve cognitive, behavioral, and affective learning outcomes. Our study contributes to training effectiveness research by focusing on the construct and predictive validity of a commonly used pre-training feedback concept, trainee learning styles.

Learning Styles

The learning style of the trainee is one individual difference that has received attention in foreign language instruction. The National Task Force of Learning Style and Brain Behavior (cited in Bennett, 1990) defines the construct as:

> that consistent pattern of behavior and performance by which an individual approaches educational experiences. It is the composite of characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how a learner perceives, interacts with, and responds to the learning environment (p. 94).

In a review of 17 studies, Hayes and Allinson (1993) concluded that learning style orientation can moderate the effectiveness of instructional methods on trainee learning. According to Sternberg and Grigorenko (1997), learning style orientation can be thought of as bridging the gap between personality and cognition, and it has been described as the "way in which each learner begins to concentrate on, process, and retain new and difficult information" (Dunn, Griggs, Olsen, Beasley, & Gorman, 1995, p. 353).

Learning style inventories/surveys measure various types of learning styles. Our study investigates the construct and predictive validity of a frequently used learning style instrument in foreign language instruction, developed by Cohen, Oxford, and Chi (2001) and later revised by Oxford, Jung, and Zhang (2005). For this study, we focus on three of the most widely used learning styles scales – visual, auditory, and tactile/kinesthetic. These scales relate to how individuals use their physical senses (i.e., sight, sound, and touch). Individuals who have a visual learning style learn best through visual means (e.g., books, video, charts, and pictures). Individuals who are more auditory in preference prefer listening and speaking activities (e.g., discussions, lectures, audiotapes, and role-plays). Individuals with a tactile/kinesthetic preference benefit from doing projects, working with objects, and moving around (e.g., games, building models, and conducting experiments).

Other learning styles measured by the Cohen et al. (2001) instrument include closure-oriented vs. open, global vs. particular, synthesizing vs. analytic, extraverted vs. introverted. For example, closure-oriented individuals focus carefully on most or all learning tasks, strive to meet deadlines, plan ahead for assignments, and want explicit direction. In contrast, individuals who are open in orientation enjoy discovery learning (in which they pick up information naturally) and prefer to relax and enjoy their learning without concern for deadlines or rules.

There are additional learning styles that are measured by other inventories (e.g., Furnham, 1996; Jackson & Lawty-Jones, 1996; Jensen, 1987; Oxford, 1995). For instance, some inventories measure how individuals handle possibilities (i.e., random-intuitive vs. concrete-sequential; Furnham, 1996; Peeke, Steward, & Ruddock, 1998). Random-intuitive individuals are future-oriented, prefer what can be over what is, like to speculate about possibilities, enjoy abstract thinking, and tend to disfavor step-by-step instruction. Concrete sequential individuals tend to be present-oriented, prefer one-step-at-a-time activities, and want to know where they are going in their learning at every moment.

It has been suggested that a student's learning style impacts training effectiveness by interacting with various instructional methods used by instructors to affect learning outcomes. For example, a student with a visual learning style may perform well with an instructor who lectures, while a tactile/kinesthetic learner may do poorly with this instructional method (Oxford, 1995). Consequently, it is important for organizations to take a more formative approach to training by assessing student learning style and using this information to tailor training to meet individual student needs. Additionally, it is suggested that the concept of learning styles be used to inform instructional design and instructor training. Therefore, learning styles are typically measured as part of a pre-training intervention to modify instructor and trainee approaches to teaching and learning, respectively, to optimize trainee learning.

There is an abundance of literature related to learning styles for students of a second language (Ehrman, 1996; Felder & Henriques, 1995; Leaver & Oxford, 2001; Oxford, 1990; Oxford, 1995; Oxford &

Anderson, 1995; Oxford & Ehrman, 1993). Although many learning style inventories have been developed and are widely used in industry, government, and education, there is a dearth of research investigating the validity of these instruments. The purpose of this study was to investigate the construct validity and predictive validity of the instrument developed by Oxford et al. (2005). Specifically, we focused on three of the most commonly measured learning styles – visual, auditory, and tactile/kinesthetic.

METHOD

Participants

Participants were 2,259 military personnel attending job-related foreign language training. These data were collected as part of a larger study designed to evaluate the effectiveness of language training in a large military organization.

Measures

Participants were asked to complete a pre-training questionnaire containing parts of Oxford et al.'s (2005) *MAP for Language Learning*. The instrument consists of seven parts, each dealing with a different type of approach to learning. For the purpose of this investigation, we focused on the learning styles most commonly measured, that is, those dealing with the physical senses – visual, auditory, and tactile/kinesthetic. All three scales consisted of 10 items each. Respondents were asked to respond on a 5-point Likert scale ranging from 1 (*never*) to 5 (*always*). A full list of items is presented in Table 1.

The criteria were the student's post-training listening, reading, and speaking proficiencies. The listening and reading proficiencies were measured using the Defense Language Proficiency Test (DLPT), a standardized proficiency test used for official decisions, such as foreign language proficiency pay. See Silva and White (1993) for a description of the DLPT. The speaking proficiency was measured via the Oral Proficiency Exam (OPE).

To control for cognitive ability, language aptitude, and educational experience, the Armed Forces Qualification Test (AFQT), Defense Language Aptitude Battery (DLAB), and self-reported previous education (i.e., high school, some college, BA or BS degree, MA or MS degree, Ph.D./Ed.D. degree, or other) were used.

Procedure

Military personnel in language training at various locations were asked to complete a comprehensive pre-training assessment of individual differences. The constructs included demographic characteristics, motivation, goal orientation, personality, learning preferences, and learning styles. The proficiency criteria were administered in a proctored setting (e.g., testing facility) after the completion of training.

Analytic Procedure

Following the practice in other studies (e.g., Chen, Faraone, Biederman, & Tsuang, 1994), the sample was randomly split into two different groups for cross-validation purposes. A three-factor a priori confirmatory factor analysis (CFA) was performed on the initial validation sample. Next, the items were revised based on tetrad analysis (Scheines, Spirtes, Gymour, & Meek, 1994), and a three-factor CFA was performed for the revised model. The list of items was further revised based on modification indices. Thereafter, the three-factor CFA was performed for the second revised model. Finally, the three-factor CFA based on the revised model was cross-validated on the holdout sample. Predictive validity was investigated by deriving composite score for each learning style based on the final results of the CFAs and performing linear regression and hierarchical linear regression.

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Criteria specified by Hu and Bentler (1999), Millsap (2002), and Vandenburg and Lance (2000) were examined to assess the overall fit of the measurement model. The ratio of chi-square to degrees of freedom (χ^2/df) was computed, with ratios of less than 2.0 indicating a good fit. However, since absolute indices can be adversely effected by sample size (Loehlin, 1992), two other relative indices, the comparative fit index (CFI) and the Tucker and Lewis index (TLI) were computed to provide a more robust evaluation of model fit (Tanaka, 1987; Tucker & Lewis, 1973). For CFI and TLI, coefficients closer to unity indicate a good fit, with acceptable levels of fit being above 0.90 (Marsh, Balla, & McDonald, 1988). For root mean square error of approximation (RMSEA), good fit is indicated by values less than 0.05; values from 0.05 to 0.10 are indicative of moderate fit and values greater than 0.10 are taken to be evidence of a poorly fitting model (Browne & Cudeck, 1993). For standardized root-mean square residual (SRMR), values less than .10 are indicative of acceptable model fit (Kline, 1998).

RESULTS

Construct Validity

To address our initial three-factor a priori model, CFA was performed using Mplus 3.13 software (Muthén & Muthén, 1998-2005). Results of the CFA are summarized in Table 2. The a priori three-factor CFA results indicated that the model did not have a good fit. In order to improve model fit, tetrad analysis was performed on each scale. One of the uses of tetrad analysis is for determining the best combination of items that measure the underlying construct. In other words, the analysis indicates which items should be dropped and which ones should be retained for further analyses (Bollen, 1990; Bollen & Ting, 1993).

Tetrad analysis was performed using Tetrad II software (Scheines, Spirtes, Gymour, & Meek, 1994). Tetrad analysis indicated the items that needed to be dropped from each scale in order to improve model fit. The specific items dropped were: 1, 2, 3, 9, and 10 for Visual; 11, 16, 17, 18, 19, and 20 for Auditory; and 26, 28, and 30 for Tactile/Kinesthetic (see Table 1).

The revision to the model improved the fit slightly. The chi-square to degrees of freedom ratio went from 5.11 to 3.40. CFI and TLI went from being in the .50s to .82 and .78, respectively. RMSEA indicates moderate fit, while SRMR indicates acceptable fit. Overall, the results indicated a need to further revise the model. In order to do so, the modification indices were examined for cross-loading items. Based on these results, Items 7, 15, 24, and 25 were also dropped from the model. Three-factor CFA based on further revision to the model on the validation sample and the hold-out sample indicated a moderate fit of the model. In neither case the RMSEA was lower than .05. In addition, the CFI and TLI were both under .95.

Predictive Validity

In order to assess the predictive validity of the learning styles, simple linear regression was performed for each of the three proficiencies – listening, reading, and speaking. Table 3 presents the means, standard deviations, and intercorrelations among the study variables. Simple linear regression and hierarchical linear regression results by each criterion are summarized in Table 4. The results indicate that learning styles significantly predict only the listening scores. Specifically, visual learning style had a significant negative effect on listening scores ($\beta = -.17$, $p < .01$). Auditory ($\beta = .04$) and tactile/kinesthetic ($\beta = -.09$) learning styles did not have a significant effect.

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Although learning styles overall did not predict reading and speaking proficiency, both visual and tactile/kinesthetic learning styles had inverse relationship with reading and speaking.

In order to investigate whether learning styles have incremental validity over cognitive ability and previous education, a hierarchical linear regression (HLR) was performed in which AFQT and previous education were entered in Step 1 and the three learning styles were entered in Step 2. Table 3 summarizes the results of the hierarchical linear regression. Cognitive ability and education significantly predicted listening and reading scores, but not speaking scores. In addition, visual learning style predicted listening scores even after controlling for the other variables ($\beta = -.17$, $p < .01$). Visual learning style did not predict reading or speaking. As was the case with simple linear regression, auditory and tactile/kinesthetic styles did not have an effect on any of the proficiencies.

Finally, another HLR was performed in which DLAB was added to cognitive ability and previous education in order to control for language aptitude. Once again the control variables significantly predicted listening and reading scores but not speaking scores. Furthermore, visual learning style continued to have an effect only on listening scores ($\beta = -.16$, $p < .01$), while auditory and tactile/kinesthetic learning styles did not significantly predict any of the proficiencies.

DISCUSSION

The purpose of the present study was to investigate the construct validity and predictive validity of three of the most commonly measured learning styles from Oxford et al.'s (2005) learning style instrument. Establishing the construct validity of this instrument is important because it has not been previously demonstrated in the literature, and the literature indicates that learning styles may have an important influence on training effectiveness. If training designers and instructors are able to understand how student learning styles impact training outcomes and effectiveness, training curriculums can be designed to meet the needs of students with a variety of learning styles.

Our analyses provided some evidence of construct validity of the instrument. The results of a priori three-factor CFA suggested that the model had moderate to poor fit. As expected three-factor CFA based on tetrad analysis had better fit compared to the a priori three-factor CFA. Revising the model based on the modification indices and dropping cross-loading items resulted in moderate to good fit. The final revised model had just as good a fit on the hold-out sample, indicating the robustness of the final model. However, our results suggest that the measurement of the construct could be improved.

Although the learning styles seemed to have moderate construct validity after modification, for the most part, they did not predict the criteria. Visual learning style was the only learning style scale that had a significant predictive relationship with listening proficiency. This significant predictive relationship with listening proficiency persisted even after controlling for cognitive ability, previous education, and language aptitude. It should be noted, however, that although visual learning style significantly predicted listening proficiency, the amount of variance it explained was very low (.03 to .04). None of the learning styles were predictive of reading or speaking proficiency. It is interesting to note that visual learning style had a significant negative relationship with listening proficiency and non-significant negative relationship with reading and speaking proficiencies. One possibility why visual learning style had a negative relationship with listening proficiency is that the learners were mainly visual but the acquisition of listening skills in the classroom did not occur through a visual modality.

Our results indicate that individual differences in learning styles have little impact on trainee proficiency outcomes from a standardized, classroom-based language training program in an applied setting. It should be noted that the learning styles were collected by the researchers but feedback was not given to the instructor and used for student feedback or class modification. The goal was to determine the impact of the pre-existing learning style. Although not conclusive, our results suggest that practitioners should use learning styles with caution. At the very least, practitioners should examine the influence of learning styles in their training context. It might be that learning styles are good for creating an awareness of different channels of learning input and that they inform learning or teaching behavior but have little or no direct effect on learning outcomes. Future research might look at the indirect effects of learning styles on outcomes. Until more research can be done, we encourage practitioners not to treat learning styles as a silver bullet.

Limitations & Directions for Future Research

There are several limitations of this study that are noteworthy. The first limitation is related to generalizability. The adult learner/military sample used to validate the instrument may not be reflective of the general population. Another limitation is that the instrument was administered as part of a larger questionnaire. The items related to learning styles were presented towards the end of the survey and therefore, rater fatigue may have affected responses. Furthermore, although there are several other learning styles that have been discussed in the literature our study only investigated learning styles related to the physical senses. A further possible limitation of the study was that the sample size was reduced drastically because of unavailability of test scores on individuals.

This study suggests many important avenues for future research. Because this instrument was validated on adult learners in a military environment, it is important that it be validated on other groups. In addition, in this study we examined each learning style on its own. Another way to investigate the validity of the learning styles is to consider the individual's standing on each style. In other words, examining the relationship of learning styles profiles to outcome variables would be a fruitful avenue for future research. Furthermore, this study suggests a possible interaction between learning style and teaching style, or instruction modality. The pursuit of research studying indirect relationships between learning styles and criteria would be useful. Future research could employ a multi-level modeling approach to investigate this linkage. Finally, it would also be worthwhile to explore the construct and predictive validity of other learning styles. Or, to be radical, we encourage creating and measuring alternative conceptualizations of learning styles and using different assessment techniques.

To summarize, our study provides initial empirical evidence of construct validity and very limited evidence of predictive validity of three factors on Oxford et al.'s (2005) *MAP for Language Learning.* Although further research on other samples is needed before any conclusive statements can be made, our study suggests that learning styles may have very limited impact on training criteria. Our study provides a reduced list of items that can be used to assess learning styles related to the physical senses. Furthermore, our study lays the groundwork for future research to investigate the utility of including learning styles as an individual difference variable in future military research on training effectiveness.

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Table 1. Items for each of the three constructs from *MAP for Language Learning*.

Items
Visual
1. I remember something better if I write it down.
2. I like to take many notes.
3. I listen better by visualizing numbers, pictures, or words in my head.
*4. I learn better by underlining or highlighting the important parts as I read.
*5. I learn better by writing something repeatedly.
*6. I understand better when I have written instructions.
7. I remember things that I read better than things that I hear.
*8. I like to find locations on a map.
9. I like to see charts or tables when I study.
10. I learn better when I see someone demonstrate.
Auditory
11. I remember something better if I talk it over with someone else.
*12. I prefer to learn by listening to someone else.
*13. I learn something better when I explain it to someone else.
*14. I like to have oral directions for tasks.
15. I like to listen to music when I study.
16. I prefer a quiet setting for studying.^{R}
17. I remember something better when someone explains it out loud.
18. I remember things that I hear better than things that I read.
19. I learn something better when I say it repeatedly.
20. I like to use sound files (e.g., MP3s, CDs, tapes, etc.) to help me learn.
Tactile/Kinesthetic
*21. I need frequent breaks when I study.
*22. I avoid sitting at a desk when I don't have to.
*23. I think better when I can move around.
24. I like a lot of physical activity.
25. Sitting still is the best way for me to concentrate.^{R}
26. I enjoy building or making things.
*27. I remember better when I can get up and move around.
28. I like to draw pictures or tables to help me learn.
*29. I'd rather just start doing things rather than pay attention to directions.
30. I remember better when I can touch real objects.

Note. R = reverse-scored. * Retained items on the final model.

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Table 2. Comparison of model fit statistics for three-factor CFAs.

Model	*N*	X^2	Df	X^2/Df	CFI	TLI	RMSEA	RMSEA 90% CI	SRMR
A-priori	508	2053.97	402	5.11	.58	.55	.09	[.09 - .09]	.11
Revised based on tetrad analysis	516	344.20	101	3.40	.82	.78	.07	[.06 - .08]	.08
Revised based on modification indices	516	121.53	51	2.38	.92	.90	.05	[.04 - .06]	.05
Final model on holdout sample	577	143.51	51	2.81	.92	.89	.06	[.04 - .07]	.05

Note. CFI = comparative fit index; TLI = Tucker-Lewis index (also known as the non-normed fit index); RMSEA = root mean square error of approximation; SRMR = standardized root-mean-square residual.

Table 3. Study variable means, standard deviations, and intercorrelations.

Model	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Visual	3.56	.60	(.56)								
2. Auditory	3.34	.56	.37***	(.47)							
3. Tactile/Kinesthetic	3.16	.59	.09	.16*	(.68)						
4. AFQT	77.09	15.72	.01	.06	-.02	--					
5. DLAB	93.92	19.33	-.05	.06	-.02	.56***	--				
6. Education	2.29	.831	.06	.17*	.04	.28***	.27***	--			
7. Listening	36.76	5.34	-.20**	.03	-.11	.23**	.34***	.15	--		
8. Reading	40.65	6.57	-.15*	.03	-.08	.34***	.37***	.23***	.67**	--	
9. Speaking	4.03	1.09	-.10	.04	-.03	.14***	.18*	.04	.51***	.43***	--

Note. $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$; reliabilities are located in the diagonal; $N = 175$.

Table 4. Simple linear and hierarchical linear regression results for learning styles predicting proficiency.

Step	*Listening*		*Reading*		*Speaking*	
	R^2	ΔR^2	R^2	ΔR^2	R^2	ΔR^2
1. Learning Styles Only	.04*		.01		.03	
1. AFQT, Education	.09***		.15***		.02	
2. Learning Styles	.13***	.04*	.16***	.01	.04	.02
1. AFQT, Education, DLAB	.12***		.17***		.04	
2. Learning Styles	.16***	.03*	.18***	.01	.06	.02

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

Note. Please do not cite without permission from the authors.

ABOUT SWA CONSULTING INC.

SWA Consulting Inc. (formerly Surface, Ward, and Associates) provides analytics and evidence-based solutions for clients using the principles and methods of industrial/organizational (I/O) psychology. Since 1997, SWA has advised and assisted corporate, non-profit and governmental clients on:

- Training and development
- Performance measurement and management
- Organizational effectiveness
- Test development and validation
- Program/training evaluation
- Work/job analysis
- Needs assessment
- Selection system design
- Study and analysis related to human capital issues
- Metric development and data collection
- Advanced data analysis

One specific practice area is analytics, research, and consulting on foreign language and culture in work contexts. In this area, SWA has conducted numerous projects, including language assessment validation and psychometric research; evaluations of language training, training tools, and job aids; language and culture focused needs assessments and job analysis; and advanced analysis of language research data.

Based in Raleigh, NC, and led by Drs. Eric A. Surface and Stephen J. Ward, SWA now employs close to twenty I/O professionals at the masters and PhD levels. SWA professionals are committed to providing clients the best data and analysis with which to make solid data-driven decisions. Taking a scientist-practitioner perspective, SWA professionals conduct model-based, evidence-driven research and consulting to provide the best answers and solutions to enhance our clients' mission and business objectives. SWA has competencies in measurement, data collection, analytics, data modeling, systematic reviews, validation, and evaluation.

For more information about SWA, our projects, and our capabilities, please visit our website (www.swa-consulting.com) or contact Dr. Eric A. Surface (esurface@swa-consulting.com) or Dr. Stephen J. Ward (sward@swa-consulting.com).