Journal of Educational Psychology
2006, Vol. 98, No. 1, 238–246

0022-0663/06/$12.00 DOI: 10.1037/0022-0663.98.1.238

Perceptual Learning Style and Learning Proficiency: A Test of the Hypothesis

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Given the potential importance of using modality preference with instruction, the authors tested whether learning style preference correlated with memory performance in each of 3 sensory modalities: visual, auditory, and kinesthetic. In Study 1, participants completed objective measures of pictorial, auditory, and tactile learning and learning style self-assessments. The results indicate that objective test performance did not correlate with learning style preference. In Study 2, the authors examined in more detail the information participants used to answer the learning style self-assessment. The findings indicate that participants answered the inventory using general memories and beliefs rather than specific examples of learning in different modalities. These results challenge the hypothesis that individuals learn best with material presented in a particular sensory modality.

Keywords: learning styles, sensory modality, memory, self-report questionnaires, metacognition

Within the field of education, learning styles have received much attention, both pedagogically (e.g., Dunn, 1983; Sadler-Smith, 2001) and in research (e.g., Barbe & Milone, 1981; Halsne & Gatta, 2002). Although learning style is difficult to define (Cassidy, 2004), a person's learning style is hypothesized to be a combination of cognitive, affective, and psychological characteristics that describe how that individual interacts with his or her environment. Theis (as cited in Dunn, Griggs, Olson, & Beasley, 1995) described learning style as a set of biological and developmental characteristics that make identical instruction for learners either effective or ineffective. Theoretically, individuals differ in the sense modality of stimuli from which they best absorb, retain, and process new information (Cassidy & Eachus, 2000; Dunn, 1983; Harrison, Andrews, & Saklofske, 2003). Specifically, how well a person absorbs and retains information depends largely on whether the information was received in the person's preferred learning modality (Zapalska & Dabb, 2002). For instance, a "visual learner" is hypothesized to learn optimally with pictorial or other visual stimuli such as diagrams, charts, or maps, whereas an "auditory learner" performs best with spoken stimuli, like a lecture. According to learning style theory, a person who is a visual learner needs to see, observe, record, and write to best learn (Dunn, 1993; Zapalska & Dabb, 2002); an auditory learner prefers information that is spoken and heard, as it is in dialogue and discussion (Dunn, 1993; Zapalska & Dabb, 2002); and a kinesthetic learner prefers to learn in an environment where material can be touched and he or she can be physically involved with the to-be-learned information (Dunn, 1993; Zapalska & Dabb, 2002).

For the longest time, researchers and educators alike believed that a person's intelligence was what influenced how a person learned, but subsequent testing of this hypothesis indicated that students with the same IQ performed significantly differently with similar learning tasks (Harrison et al., 2003). During the last 35 years, there has been a major effort to investigate the topic of learning style, and instruments to measure and explain individual learning styles, other than the now outdated IQ-based hypothesis, have arisen from this research. The purpose of each of these instruments is to identify the preferred learning style of each individual, which in turn should result in modified instructional methods to optimize each individual's learning. However, researchers have observed a great deal of variability between many of these devices; in fact, a great many of the available learning style instruments have never been validated (Harrison et al., 2003). Learning style research has simply identified learning styles through self-report questionnaires (e.g., Delahoussaye, 2002; Haar, Hall, Schoepp, & Smith, 2002; Loo, 2002) without assessing the basic hypothesis underlying the theory. Specifically, the correlation between one's self-assessed learning style and one's memory performance using different stimulus types has not been examined.

The purpose of Study 1 was to test the learning styles hypothesis using standardized memory tests involving visual, auditory, and tactile learning. According to learning style theory, individuals should show superior learning and memory for material presented in their preferred modality. To assess this, we used tests of memory for pictures, stories, and tactile shapes, selecting standardized tests with good psychometric properties. The three objective measures used to test visual, auditory, and kinesthetic learning were the Rey–Osterrieth Complex Figure Test (Rey; Lezak, 1995; Rey & Osterrieth, 1941/1944/1993), the Babcock Story Recall test (Babcock; Babcock, 1930; Babcock & Levy, 1940; Lezak, 1995), and the Tactual Performance Test (TPT; Arthur, 1947; Lezak,

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Portions of this work were presented at the 15th Annual Meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science, Montréal, Quebec, Canada, July 2005. This research was supported, in part, by a Natural Sciences and Engineering Research Council of Canada grant to Katherine D. Arbuthnott.

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1995). Participants' learning styles were measured using a self-assessment tool, the Barsch Learning Style Inventory (BLSI) questionnaire (Barsch, 1991), and a self-report learning style preference question. If the learning style hypothesis is correct, we would expect learning style to be correlated with the appropriate memory test.

Research indicates that individuals may differ in their cognitive performance—particularly in performance related to memory—according to the match between their time-of-day preference and the time of a test (Song & Stough, 2000). This factor was also considered in Study 1, and the participants' time-of-day preferences were measured using the Morningness–Eveningness Questionnaire (MEQ; Horne & Östberg, 1976) and compared with the time of day each person completed the study. Because the results of Study 1 did not support the learning style hypothesis, we then conducted a second study using qualitative methodology to determine the information that people consider as they respond to a learning style questionnaire.

Study 1

Method

Participants. Sixty-five university students (54 women, 11 men) with a mean age of 23.25 years ($SD = 8.3$; range: 18–50 years) volunteered to participate in this study. All participants were recruited from the University of Regina (Regina, Saskatchewan, Canada) Department of Psychology Participant Pool and received credit in an introductory psychology class for participating. The study required approximately 1.50–1.75 hours to complete.

Materials. Two questionnaires and three standardized memory tests were administered to each of the participants: the BLSI (Barsch, 1991), the MEQ (Horne & Östberg, 1976), the Rey (Lezak, 1995; Rey & Osterrieth, 1941/1944/1993), the Babcock (Babcock, 1930; Babcock & Levy, 1940; Lezak, 1995), and the TPT (Arthur, 1947; Lezak, 1995). Prior to completing these instruments, participants also responded to a single question about which learning style they believed described them best, choosing from among five options (see Appendix A).

The BLSI (Barsch, 1991) provides a score for each of three learning modalities: visual, auditory, and kinesthetic. This questionnaire has 24 three-point Likert-type scale items with response options of *often*, *sometimes*, and *seldom*. The questionnaire is scored by assigning points to each response (5 for *often*, 3 for *sometimes*, and 1 for *seldom*), with a maximum score of 40 and a minimum score of 8 for each modality. The highest score achieved between the three modality types indicates the individual's learning style. Although there are no published psychometric measures for this instrument, we calculated Cronbach's alphas for the present sample and observed reliability measures of .54 for visual, .56 for auditory, and .38 for kinesthetic items.

The MEQ (Horne & Östberg, 1976) consists of 14 four-point Likert-type scale items and 5 scale items that require the participant to place a cross along an appropriate point on the scale. This questionnaire is used to determine a participant's time-of-day preference by using five time-of-day definitions: *definitely a morning type*, *moderately morning type*, *neither type*, *moderately evening type*, and *definitely evening type* person.

The three standardized measures of memory were administered and scored in the standardized manner (Lezak, 1995; Spreen & Straus, 1998). Visual memory was assessed using the Rey (Rey & Osterrieth, 1941/1944/1993). This test is administered by showing each participant an abstract line drawing for 30 s, after which the drawing is removed and the participant attempts to recreate the drawing from memory. Delayed recall of the picture is tested at a 20-min delay. Performance is scored on the basis of correct representation and placement of each of 18 separate and distinct features, with a maximum score of 36. Berry, Allen, and Schmitt (as cited in Lezak, 1995) found good interrater reliabilities ($r = .91$–$.98$) and good test–retest reliabilities ($r = .60$–$.76$) for this measure.

Auditory memory was assessed using the Babcock (Babcock, 1930; Babcock & Levy, 1940), which consists of a short story that is read aloud to each participant. The participant then immediately recalls the story in as much detail as he or she can. The story is subsequently read to the participant a second time, and then recalled after a delay of 20 min. This test is scored by assigning 1 point for each item of the story that the participant accurately recalled, with a maximum score of 21 points. Kreutzer et al. (as cited in Lezak, 1995) found interrater reliabilities for the Babcock of .79–.92.

Kinesthetic memory was tested using the TPT (Arthur, 1947), which consists of a wooden board with 10 different geometric shapes cut out of it (similar to a child's 3-D puzzle). Participants were blindfolded without seeing the board or the 10 shapes, and the 10 shapes were placed to the side of the board. Using his or her dominant hand first, each participant was timed while placing each piece into its corresponding slot on the board. Each participant completed this task three times: once with his or her dominant hand, once with the nondominant hand, and finally with both hands. At the end of the third trial, the board and the 10 geometric pieces were removed, the participant removed the blindfold, and he or she drew the shapes and the board as accurately as possible. There was no delay between completing the last part of the TPT and the drawing portion of the test. Two scores were obtained with this test; one was based on the total amount of time it took to place the pieces in the correct slots, and one was based on the representation and placement of the shapes in the drawing (maximum score = 20). The scores for the timed portion and the drawing portion were calculated and analyzed separately. In studies by Thompson and Parson (as cited in Lezak, 1995) test–retest reliabilities for the TPT for time, memory, and location scores were .68–.93.

Procedure. After giving informed consent, participants completed the questionnaires and tests, with order counterbalanced across participants. Within each category, the order of the specific tests was also completely counterbalanced. To allow for a 20-min delay between each test situation, the tests were presented in the following manner: For example, the dominant-hand TPT was administered first; upon completion, the board was removed, and then the Rey was given, followed by the Babcock. The next step was to give the nondominant-hand TPT and then the delayed Rey and the delayed Babcock. The last condition to be met was the both-hands TPT. Once all three conditions of the TPT had been met, the board and the 10 geometric pieces were removed, the participant removed the blindfold, and he or she drew the shapes and the board as accurately as possible.

Results

The alpha level of all analyses was set at .05.

Learning style. Participants' learning styles were assessed in two manners: direct self-report and the BLSI. Each assessed a participant's dominant learning style as visual, auditory, kinesthetic, or mixed. The results from these two assessments did not show good correspondence: Only 29 of the 65 participants (44.6%) were classified as having the same learning style using both assessment procedures. This impression of poor correspondence was verified with a correlational analysis, which indicated a nonsignificant relationship between the two measures (Spearman's $\rho = .057$).

Comparison of learning style and standardized memory tests. For this analysis, Rey and Babcock total scores (immediate + delayed recall) were used. Given the variability of learning style assessment using our two measures, we used two correlational analyses to assess the consistency between learning style and performance and for each learning style measure. The first analysis involved the BLSI. For this analysis, Pearson product–moment correlations were computed between scores on each component of the BLSI (visual, auditory, and kinesthetic) and the scores for the standardized memory tests. The results of this analysis are shown in Table 1. As can be seen, there were no significant relationships between learning style and objective memory. It is interesting to note that there was a positive correlation between kinesthetic learners on the BLSI and performance on the Rey visual-memory test, a finding that challenges learning style theory. Within the BLSI itself, scores on the visual component were negatively correlated with scores on the auditory component ($r = -.50$, $p < .01$), suggesting that participants interpreted these elements as opposite to each other in some way.

This analysis also indicated significant correlations between the two TPT scores (drawing and time to completion; $r = .41$) and between the Rey and both components of the TPT (rs $= .38$ for time and .29 for drawing). This suggests that to some degree, memory tests for visual and tactile memory tapped the same underlying memory processes.

The second analysis involved the direct self-report of learning style. For this analysis, the learning style selected was coded nominally (1 = *visual*, 2 = *auditory*, 3 = *kinesthetic*, 4 = *mixed*). Similarly, for the standardized measures, a participant's highest score from among the three tests was given the same nominal code. A Spearman's rho rank correlation was then conducted between these nominal codes for the learning style and the objective measures. The results of this analysis are shown in Table 2. As can be seen, there were also no significant relationships between self-reported learning style and standardized memory performance.

To determine whether the relationship between learning style and objective memory would be evident for those who showed a consistent learning preference across the two learning style measures, we reconducted the Spearman's rho analysis for only the 29 participants who demonstrated this consistency. Even for this group, there was not a significant relationship between learning style and objective measures ($\rho = -.024$).

MEQ. To determine whether the time of day at which the tests were performed influenced performance, we used the MEQ scores to identify two subsamples of participants: those who completed the study during their preferred time of day ($n = 22$) and those who completed the study during their nonpreferred time of day ($n = 43$). The first correlational analysis between learning style and objective performance, using the BLSI scores, was reconducted for each of these groups separately. These analyses are shown in Tables 3 and 4.

As can be seen in Table 3, for the participants who completed the study during their preferred time of day, there was no relationship between learning style and objective memory performance. However, as with the entire group, this analysis indicated a significant relationship between the Rey and the timed portion of the TPT ($r = .58$, $p < .01$). Unlike the overall results, there was a significant negative relationship between performance on the Rey and the Babcock ($r = -.49$, $p < .01$), consistent with the negative correlation between the auditory and visual scores on the BLSI ($r = -.50$, $p < .01$). These results may suggest a difference between memory for verbal and nonverbal material for this subgroup of participants. However, these relationships were not modified by specific learning style, so the results show no evidence of

Table 2
Spearman's Rho Correlation Matrix of Learning Style Self-Report Category and Categorized Memory Performance Using Both the Time and Drawing Scores of the Tactual Performance Test

Measure	1	2	3	4
1. Self-report	—	.16	.16	.14
2. Test performance (time)		—	.27*	.62**
3. Test performance (drawing)			—	.73**
4. Test performance (overall)				—

Note. Test performance (time) = best performance in objective measures using only the timed results of the Tactual Performance Test; Test performance (drawing) = best performance in objective measures using only the drawing results of the Tactual Performance Test; Test performance (overall) = best performance in objective measures using both the timed and the drawing results of the Tactual Performance Test.
* $p < .05$. ** $p < .01$.

Table 1
Pearson Product–Moment Correlation Matrix of the Standardized Memory Tests and the Barsch Learning Style Inventory

Measure	1	2	3	4	5	6	7
1. Barsch visual	—	−.50**	.12	.00	.04	−.14	−.07
2. Barsch auditory		—	−.08	−.07	.01	.05	.02
3. Barsch kinesthetic			—	.26*	.09	.08	.06
4. Visual				—	.15	.38**	.29**
5. Auditory					—	−.09	.17
6. Kinesthetic time						—	.41**
7. Kinesthetic drawing							—

Note. Visual = Rey–Osterrieth Complex Figure Test total score; Auditory = Babcock Story Recall test total score; Kinesthetic time = Tactual Performance Test total time; Kinesthetic drawing = Tactual Performance Test location and accuracy drawing.
* $p < .05$. ** $p < .01$.

Table 3
Pearson Product–Moment Correlation Matrix for Participants Who Completed the Study During Their Preferred Time of Day ($n = 22$)

Measure	1	2	3	4	5	6	7
1. Barsch visual	—	−.50*	.15	−.09	−.05	−.16	−.07
2. Barsch auditory		—	−.19	.09	.05	.33	.29
3. Barsch kinesthetic			—	.08	.14	.03	.07
4. Visual				—	−.49*	.58**	.15
5. Auditory					—	−.24	.06
6. Kinesthetic time						—	.43*
7. Kinesthetic drawing							—

Note. Barsch = Barsch Learning Style Inventory; Visual = Rey–Osterrieth Complex Figure Test total score; Auditory = Babcock Story Recall test total score; Kinesthetic time = Tactual Performance Test total time; Kinesthetic drawing = Tactual Performance Test location and accuracy drawing.
* $p < .05$. ** $p < .01$.

Table 4
Pearson Product–Moment Correlation Matrix for Participants Who Completed the Study During Their Nonpreferred Time of Day (n = 43)

Measure	1	2	3	4	5	6	7
1. Barsch visual	—	−.48*	.12	.05	.08	−.15	−.12
2. Barsch auditory		—	−.01	−.16	−.03	−.09	−.13
3. Barsch kinesthetic			—	.35*	.07	.11	.06
4. Visual				—	.30	.30	.37*
5. Auditory					—	−.05	.24
6. Kinesthetic time						—	.40*
7. Kinesthetic drawing							—

Note. Barsch = Barsch Learning Style Inventory; Visual = Rey–Osterrieth Complex Figure Test total score; Auditory = Babcock Story Recall test total score; Kinesthetic time = Tactual Performance Test total time; Kinesthetic drawing = Tactual Performance Test location and accuracy drawing.
* $p < .05$.

a relationship between learning style and memory performance itself, even for people who were tested at their optimal time of day.

For participants who completed the study during their nonpreferred time of day, the results were somewhat different (see Table 4). For this group, as for the entire sample, there was a positive relationship between scores on the BLSI kinesthetic component and performance on the Rey. This suggests that those who identified themselves as kinesthetic learners actually performed better on a visual memory test when they were tested at their nonpreferred time. However, this group showed a significant relationship between performance on the Rey and the drawing score of the TPT but not the time score, unlike the participants who completed the study during their preferred time of day. As for the participants who completed the study at their preferred time, there was a negative correlation between scores on the auditory and visual measures of the BLSI. These participants also showed a positive relationship between performance on the Rey and Babcock memory measures, opposite to the pattern observed for participants who completed the study at their preferred time. We also looked at order effects and found only one difference between the participants who were presented the questionnaires first and the participants who completed the objective measures first. We no longer found a significant relationship between performance on the timed portion of the TPT and performance on the Rey when the questionnaires were presented last.

Discussion

The purpose of this study was to test the central hypothesis that learning styles reflect differential ability in remembering material presented in different sensory modalities. Specifically, those assessed as visual learners should show greatest ability to recall material presented in pictorial form, whereas those assessed as auditory learners should show better memory for verbal material, and kinesthetic learners should have proficiency to learn in a tactual environment. The results of this study indicate that this was not the case, because there were no significant correlations between learning style and objective memory performance, except for the unexpected relationship between kinesthetic style as assessed by the BLSI and visual memory (i.e., the Rey). These results cast doubt on the central assumptions of the learning style model as it is used in education. Performance on the self-report and self-assessment questionnaires was also not as expected, with only 44.6% of the respondents classifying themselves as having the same learning style on both the questionnaires. This pattern was not influenced by time-of-day factors—the expected relationships were not observed for either MEQ group.

According to both the self-report questionnaire and the self-assessment questionnaire, 40% and 60% of the participants, respectively, indicated that they were visual learners, whereas 16% and 8%, respectively, indicated a kinesthetic learning preference. However, when the participants completed the standardized memory tests, 23% performed best with the visual test (Rey), and 52% performed best with the tactile test (TPT; see Figure 1). This indicates that, as with other metacognitive judgments (de Carvalho Filho & Yuzawa, 2001; Kelemen, Frost, & Weaver, 2000; Kruger, & Dunning, 1999; Vadhan & Stander, 1994), people are not particularly accurate at predicting factors that influence their memory performance.

Although women greatly outnumbered men in our sample, we do not think that sex differences can account for the findings. No sex differences have been observed in the visual and kinesthetic objective measures used in this study (Boone, Lesser, Hill-Gutierrez, Berman, & D'Elia, 1993, for the Rey; Yeudall, Reddon, Gill, & Stefanyk, 1987, for the TPT), and although there is no specific test of sex differences for the Babcock, sex-difference tests with other auditory measures have been inconclusive (Lezak, 1995). Thus, we do not believe that the preponderance of women in our sample (which generally reflects enrollment in psychology classes at our institution) invalidates these results.

In contrast to learning style theory, it appears that people are able to learn effectively using all three sensory modalities. Anecdotally, components of all three modalities were used in learning many of these standardized memory items. Although they did not examine sensory learning specifically, Harrison et al. (2003) proposed that learning is not static but, instead, is situationally motivated and goal motivated. Many of the participants in this study spoke out loud when completing the TPT by saying the name of each shape. The results of this study raise serious doubts about learning style specificity and instead support the idea that each individual uses a combination of different learning modalities to

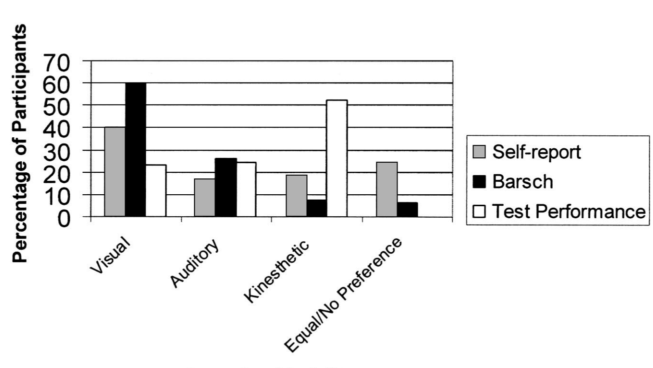

Figure 1. Percentages of participants scoring highest in each preferred modality using self-report, the Barsch Learning Style Inventory, and standardized memory tests.

learn effectively. For example, when one learns what a rose is, one does not truly understand this concept unless one can see the flower and its vibrant colors, feel the prick of its thorns or the silkiness of its petals, smell its distinctive odor, and hear its name. If one only relied only on one's tactile abilities, then a rose might be nothing more than a painful object to avoid; to truly learn what a rose is, all sensory modalities must be used.

Learning style can be considered to comprise three fundamental components: information processing, instructional preference, and learning strategy (Cassidy, 2004). Information processing, as described by Cassidy (2004), is how an individual intellectually approaches the processing of information. Curry (as cited in Cassidy, 2004) described instructional preference as a person's preferred learning environment, but went on to say that this preference is one of the hardest things to measure because it is the most susceptible to external influence. Learning strategies are methods that students adopt while studying. There is a distinction between learning styles, which may be more automatic, and learning strategies, which are optional (Hartley; as cited in Cassidy, 2004). However, learning style essentially addresses an individual's memory for different types of sensory stimuli when using these components. This study essentially examined the information-processing component of learning style theory, but participants' performance would have been influenced by all three components. However, even if participants reformulated each objective task into a preferred modality strategically (e.g., verbally describing the complex picture stimulus to themselves), performance still should have been superior for individuals who did not transform the stimuli (i.e., there should have been better performance on the Rey for visual learners and on the Babcock for auditory learners).

Study 2

The results of Study 1 suggest that an assessment of learning style does not provide information about an individual's best learning environment. However, people are strongly attracted to this idea, and our participants had no difficulty answering either the self-report question about their learning style or the 24 questions of the BLSI. Because these intuitions and responses apparently have little to do with objective memory, what do people's responses to such questions indicate? To investigate this question, we conducted a qualitative study of response to the BLSI, asking participants to indicate what information they had used to answer each question. It is possible that individuals report actual differences in their learning experiences in learning style questionnaires even though the differences are not related to their learning efficiency with different sensory materials. The purpose of Study 2 was to investigate this possibility.

Although individuals are not always aware of the reasons for their selections (e.g., Nisbett & Wilson, 1977), we reasoned that participants must be accessing some types of information to respond to the items in the BLSI and that they would be aware of at least some of this information. Thus, although the qualitative self-report has its limitations, reflection on thoughts used to respond to metacognitive questions such as those of the BLSI can be useful in understanding what such self-report questionnaires reflect.

Method

Participants. Ten university students volunteered to participate in this study. All 10 participants were recruited from the University of Regina Department of Psychology Participant Pool and received credit in an introductory psychology class for participating. Participants' ages and sexes were not recorded, but this sample was similar in these characteristics to the sample in Study 1.

Materials and procedure. As in Study 1, participants completed the 24-item BLSI. Following completion of this questionnaire, participants were asked, on a question-by-question basis, why they had selected that response ("You answered _____; can you tell me why you answered this way?"; see Appendix B). Answers to these interview questions were tape recorded and transcribed prior to qualitative analysis.

Results

Logically, to answer a question about one's efficiency of learning with a particular sensory modality, one would need to retrieve memories of one's performance when learning such material. For example, to answer a question about whether one is better at following written or oral directions, a person would need to bring to mind events when he or she had been given both types of directions and then recall how he or she had performed in each type of circumstance. Given the evidence in Study 1 that responses to the BLSI are not related to objective memory performance associated with different sensory modalities, it appears that individuals do not answer learning style questionnaires this way. The purpose of this study was to examine this assumption and to determine what types of evidence individuals do use to respond to questions about their learning style. To this end, we analyzed answers about how participants responded to each question qualitatively, using a content-analysis procedure to determine the category of evidence participants reported. Responses that did not relate to how participants had answered the question but, rather, to retrieval of additional events related to that question (e.g., "I guess I could have thought of how I learn things at work instead") were not analyzed.

Initial identification of theme units indicated that participants' responses could be sorted into five categories: specific examples, general examples, preferences, self-efficacy beliefs, and habits and routines. Examples of responses for each of these categories are given in Table 5.

In general, our results indicate that participants only rarely thought of specific examples in response to the questions (6.3% of responses). Rather, they answered on the basis of general memories (26.7% of responses), personal preferences (27.9% of responses), self-efficacy beliefs (28.3% of responses), or habits and routines (10.8% of responses; see Figure 2). In total, participants reported only 15 specific examples over the 240 opportunities (10 participants $\times$ 24 questions; see Figure 3). Furthermore, when specific examples were brought to mind in response to a question, participants considered only one such example, often a recent (e.g., "last week I had to go to my friend's house and I wasn't sure where she lived because I had never been there before, I just looked at the map and found it") or distinctive (e.g., "maybe not if someone was giving me instrument sounds, which I can remember from music class I did not have a clue at, except to say it was a string or a horn") event. There was not a single instance in which a participant brought to mind several events and then chose his or her answer on the basis of their relative experience over many examples.

Table 5
Examples and Frequencies of Each Type of Information Used to Answer the Barsch Learning Style Inventory (Study 2)

Type of information	*n*	%	Example
Specific	15	6.3	It came to my mind because I was actually studying for my psych test a couple of days ago, and I would write especially if it was a listing question.
			In my biology degree before I had an oral exam. . . . I just totally tensed up and did not do really well at all.
			I am taking a Spanish class right now and there are a lot of the same sounding words. I have to really listen. But when it comes to music I don't know if I could tell sounds apart.
General	62	25.8	I can think of times in school or at the pool and we always use charts, and sometimes it's fun being creative. . .
			A lot of time I work on my computer so I forget even common words, so I would just spell it out loud in my head.
			If the text is dry and boring and it makes absolutely no sense then I am not going to be able to read through it, so then I would rather listen to a lecture.
			I am usually the navigator and am not in the driver's seat a lot so people hand me maps and I am just used to it. When I was younger my dad always gave me the map so I am used to it.
Preferences	66	27.5	I just like to see it in writing.
			I just don't like the [tools]. I am from a farm and there are tools there and I don't use them at all.
			I hate making charts and graphs. I would rather write them out with words than make a chart.
			It is just more interesting. If there is a topic I like I would go to the library and read about it.
Self-efficacy beliefs	68	28.3	I suck at puzzles. I avoid them like crazy.
			I snack—chips, pop, I have to keep my mouth entertained while I'm studying because I lose concentration if I need something to snack on when I'm studying.
			If I can get a visual of something in my head then I can remember it a lot better.
			I just learn better by writing.
Habits and routines	26	10.8	I really do not do this at all ever [finger spelling].
			I never have coins in my pocket at all. And keys—well sometimes they are in my pocket but usually in my purse, but I never play with them at all.
			Sometimes when I am taking notes in class I write in pen; and it is always in handwriting . . . but notes in an exam are always harder and printed . . .

Another interesting observation is that the examples participants reported using as the bases of their responses were primarily encoding events rather than examples of retrieval performance. The questions on the BLSI appeared to prime memories of study events in which participants were exposed to material in different sensory formats rather than memories of performance. It appears that the participants' attention was drawn to their experiences during learning episodes rather than to an evaluation of their subsequent memory performance following such episodes. The only response category that was potentially related to retrieval experiences was self-efficacy beliefs, which could have been formed on the basis of previous feedback on learning performance

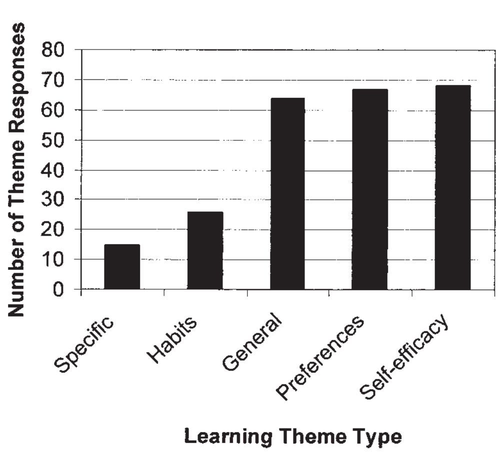

Figure 2. Numbers of individual theme units using interview questions with the Barsch Learning Style Inventory.

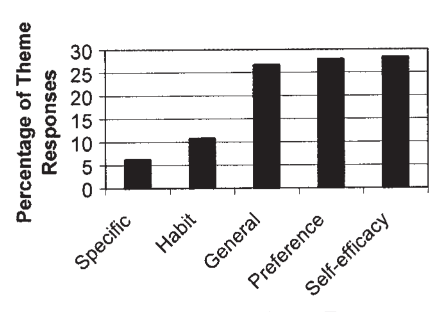

Figure 3. Percentages of individual theme units using interview questions with the Barsch Learning Style Inventory.

of various types. However, even this category did not seem to be strongly related to performance, because participants simply stated their beliefs about what they were good and not so good at without reference to any evidence for those beliefs.

In the context of their responses, participants also reported that learning was strongly influenced by contextual factors, such as whether the material was interesting (e.g., "if the person is interesting, I'll remember what they say") and whether the presentation was available for later study, as it would be with written or tape-recorded lectures. Another factor to be considered is the 41 responses in which the participants referred to more than one learning modality (e.g., "sometimes in some of my classes I can understand my professors pretty well but sometimes if I read my textbook I find that I can understand it better"); this bimodal type of learning was usually referenced in connection with whether the material was complicated or not. In contrast to the rare retrieval of explicit examples, participants specifically reported learning material that was interesting or boring 22 times. Other contextual factors, such as whether the participant was tired or in a distracting environment or whether the material was presented in a unique fashion, were also reported.

Discussion

The purpose of Study 2 was to examine the types of information participants were using to respond to BLSI questions, given the observed lack of correlation between assessed learning style and performance on memory tests for the various sensory modalities in Study 1. If participants responded to questions by considering their previous memory-performance experiences, learning style presumably would be correlated with learning performance.

The results of Study 2 suggest that the types of information participants used to guide their responses to the BLSI questions were focused instead on their preferences, their beliefs about their own abilities, and their memories of encoding events, such as lectures or map reading. The lack of correlation between reported learning styles can thus be attributed to the difference between the information that is consulted and the information that would be necessary to make performance assessments. Instead of providing information about optimal performance environments for individuals, the BLSI instead appears to present stronger information about a participant's preferences and beliefs. Such preferences could potentially influence performance by increasing a person's motivation to engage in effective memory rehearsal and other strategies, but this was not observed with the present method in that the influence of motivation on memory performance was limited. Participants were not given the opportunity to rehearse their memories of the different stimuli, because the tests were given sequentially during the entire time of the study.

Consistent with this speculation about the influence of preferential stimulus modality on motivation, the results of Study 2 also suggest that participants' sense of learning new information was dependent not only on interest in the to-be-learned information but also on the method of delivery and whether a speaker was engaging. Thus, motivational and situational factors, rather than learning style, may influence learning success as indexed by learning style inventories.

Contextual factors were also important to participants' reports of their learning. Many of the participants determined that ease of learning was a result of whether the new information was interesting, what the availability of information was, or the repeatability of the information. Although they were not asked about this specifically, many of the respondents said that if the information was presented only a single time, they would not be able to remember the information regardless of their preferred learning modality. Simplicity of information was another determinant of whether new information would be learned. The more complicated the information, the more varied the strategies became to remember new information. In addition to participants reporting using more than one modality, they also incorporated methods like mnemonics into their learning strategies. Although the participants were not specifically asked about this, this bimodal learning preference was evident in many of the participants' preference for having material delivered both visually and auditorily, even though that bimodal preference was reflected in only 1 of the 10 participants' BLSI results. This bimodal preference is also interesting because it contradicts the results of Study 1, in which not only were the BLSI visual and auditory components significantly negatively correlated but so was performance between the visual and auditory objective measures (see Table 3).

It is interesting to note that recent learning style research has also suggested such multimodality, and there is some evidence that learning style is a response—or at least a partial response—to a particular learning environment; when faced with a variety of tasks in different modalities, students report using a variety of styles depending on what the task requires (Cassidy & Eachus, 2000). Thus, despite the comments that learning preferences are the most difficult component of learning style to assess, this may be the only component that is adequately measured with most learning style instruments.

General Discussion

The purpose of these studies was to test the central hypothesis of learning style theory that individuals learn and remember more readily with certain stimulus modalities than with others. The results of Study 1 indicate that learning style assessed either through individuals' self-assessment or with a commonly used questionnaire did not correlate with objective memory performance using the various stimulus types. Study 2 then pursued the possible reasons for this lack of correlation by examining what information participants consider when responding to BLSI questions. The results of Study 2 suggest that the learning style questions did not evoke memories of learning performance or study-test episodes but, rather, of encoding events (general or specific), preferences, habits, and self-efficacy beliefs. Although these memories could, hypothetically, be related to memory performance, this is not necessarily so, as indicated by the results of Study 1.

Previous research on survey performance suggests that survey questions do not typically result in individuals engaging in detailed analysis of their previous experience, such as recall and categorization of several relevant memories (e.g., Tourangeau, Rips, & Rasinski, 2000). Rather, such questions are typically answered heuristically, with respondents using information that readily comes to mind in response to the question and then making judgments either on the basis of limited information or using other factors such as the ease with which relevant information came to mind (Sloman, 2002). This seems to be the case with learning style questionnaires, because participants did not engage in detailed analytic judgment of their learning histories, but, rather, the particular question prompted rapid retrieval of either general examples or previously formed opinions about preferences or abilities.

Given this, learning style questionnaires can provide educators with information about respondents' preferences or self-beliefs and, thus, might assist them in structuring learning events in ways that are more popular or familiar to their students. However, educators should not conclude that such efforts will improve their students' learning, except as it influences students' motivation for voluntary effort.

Future Research

The present studies yielded some important insights into metacognition in the sense of people's beliefs about their learning ability. Most of the participants were quite sure of what type of learner they believed themselves to be, yet, overall, the participants did not perform better in their prescribed learning modality, nor did they score the same on the self-assessment questionnaire. Before the conclusion that learning style questionnaires do not provide evidence of optimal stimulus modalities for learning can be accepted, however, the present results need to be replicated with other learning style instruments.

Conclusion

Researchers and educators have devoted considerable effort to trying to understand learning styles. This research has mainly examined relative rates of different styles in different populations (Delahoussaye, 2002; Harrison et al., 2003; Pyryt, Sandals & Begoray, 1998; Zapalska & Dabb, 2002). Because information is presented in an ever-increasing number of ways, learning style theory proposes that being better able to understand how people learn can lead educators to the most effective way in which to deliver information. In a parallel area, the field of metacognition explores how people think, assimilate information, and interpret to-be-learned information. The present results suggest that people's intuitions about their learning styles may be incorrectly attributed. Specifically, such styles may indicate preferences and motivations rather than inherent efficiency at taking in and recalling information through specific sensory modalities.

Consistent with the present results, Coffield, Moseley, Hall, and Ecclestone (2004) found no evidence that matching instruction to an individual's sensory strengths was any more effective than designing content-appropriate forms of education and instruction. Bloomer and Hodkinson (2000) argued that learning styles are a minor factor determining how learners react to stimuli and that the effects of contextual, cultural, and relational factors play a much larger role. The present results support such claims.

There are a multitude of learning style questionnaires designed to inform educators and other instructors about their students' learning preferences. However, the results of the present studies suggest that focusing on learning styles as defined by sensory modalities may be a wasted effort. The present studies show that although categorizing each person as a specific type of learner is easy, individuals' memory efficiency is not limited by sensory modality, nor are people able to learn in the same way in all situations. Instead, most people are likely multimodal and multisituational learners, changing learning strategies depending on the context of the to-be-learned material. Thus, helping individuals learn effective memory strategies across all stimulus modalities and contexts, rather than only assessing learning type, may prove to be better for both the student and the education system. As discussed throughout the learning styles literature, presenting material to students in multiple sensory modalities is undoubtedly beneficial to learning and interest (e.g., Lapp, Flood, & Fisher, 1999; Morrison, Bryan, & Chilcoat, 2002). The present results challenge these assertions only by suggesting that the advantage of multimodal presentation is not attributable to individual learning styles.

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Appendix A

Self-Report Learning Style Question

What word would best describe the type of learner you are?

(a) Visual
(b) Verbal
(c) Kinesthetic
(d) No preference
(e) Equal preference

Appendix B

Barsch Learning Style Reference Form Interview Questions

You answered ______________; can you tell me why you answered this way?

Questions not analyzed:

You cited recent example(s); can you give me examples that are not so recent?

Do you have examples that are not related to university?

Do you have an example of a time when this has helped you?

Received February 14, 2005
Revision received June 28, 2005
Accepted July 13, 2005 ■