Individual Differences in Learning and Remembering Music: Auditory versus Visual Presentation

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Journal of Research in Music Education 2007; 55; 48
DOI: 10.1177/002242940705500105

We examined the effects of presentation modality and learning style preference on people's ability to learn and remember unfamiliar melodies and sentences. In Experiment 1, we gauged musicians' and nonmusicians' learning efficiency for meaningful and less meaningful melodies as well as sentences when presented visually or auditorily. In Experiment 2, we tested the effects of the same variables on memory. Presentation modality did not make a difference, but learning-style preference did. Visual learners learned visually presented items faster and remembered them better than auditorily presented ones, and auditory learners did the reverse. Also, as expected, meaningful sentences were learned faster and remembered better than less meaningful ones. However, although musicians also learned meaningful melodies faster and remembered them better than less meaningful melodies, this was not the case for nonmusicians.

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An important goal in education is to find the most effective way of portraying information to beginning learners. To this end, researchers have explored various cognitive processes involved in learning, such as how information is perceived and classified, what strategies are used, and, most important for present purposes, the influence of the modality in which the information is presented and the learning style of the person (e.g., Sternberg & Grigorenko, 1997). The present study is an exploration of how different learning styles in music can affect learning rates and memory.

Music is one area where distinct auditory and visual methods of teaching exist. For instance, the Suzuki Method focuses on ear train-

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ing and performance skills (Brathwaite, 1988), whereas the alternative and more commonly used method focuses on music-reading activities (Kendall, 1988). The dominant aspect of the latter method is teaching the visual recognition of music notation, whereas the Suzuki Method focuses on the auditory aspects of music and postpones reading until proficiency with basic performance is attained, essentially trying to mimic native-language learning, in which auditory mastery of the language occurs before the written aspects are tackled (cf. Jordan-DeCarbo, 1986; Peynircioglu, Durgunoglu, & Öney-Küsefoglu, 2002).

One topic of interest in both language and music is the role of perceptual dominance with respect to learning and remembering. Researchers in several studies have found that, in general, auditory presentation leads to better learning and memory than does visual presentation (e.g., Moreno & Mayer, 1999; Thompson & Clayton, 1974). Jensen (1971), however, found that although initial learning benefits more from auditory presentation, longer-term memory benefits more from visual presentation. Further evidence for visual dominance in longer-term memory has come from studies in which investigators have looked at how people learn and remember text-based materials (e.g., DeBoth & Dominowski, 1978; Izawa, Hayden, & Isham, 1980).

Others have examined the effects of presenting musical stimuli in different modalities on such tasks as melodic and rhythmic retention and pitch-matching (Persellin, 1994) and memory for rhythm (Persellin, 1992). For instance, de Stwolinski, Faulconer, and Schwarzkopf (1988) found that participants in an auditory presentation group were more accurate when detecting harmonic alterations than were those in a sight-reading group. Conversely, Moore (1990) discovered that when subjects were studying music composition, visual presentation led to more efficient and accurate learning than auditory presentation did.

Differences between visual and auditory learning become even more important when individual preferences are considered. Because of these preferences, some people are labeled *visual learners* and others *auditory learners* (e.g., Jensen, 1971; Tallmadge & Shearer, 1969). Indeed, independent of the question of whether one mode of presentation is better than the other, there is ample evidence that individual differences are important in education (e.g., Daniel & Tacker, 1974; Stahl, 1999; Tarver & Dawson, 1978).

Another variable of interest in learning and memory is the meaningfulness of the material to be learned. More meaningful materials, such as words or intact sentences, are often learned and remembered better than less meaningful materials, such as nonsense letter-strings or randomly arranged sentences (e.g., Lappin & Lowe, 1969; Meyers & Boldrick, 1975). Similar results are found for nonverbal materials, as well (e.g., Mandler & Day, 1975). For instance, Chase and Simon (1973) found that expert chess players were able to remember, or reconstruct, the arrangements of pieces on a chessboard far better than nonexperts, but only when the arrangements were legal within the context of a real chess game, or meaningful; when the arrangements were random—less meaningful to the experts—there was no advantage of expertise on memory.

Thus, a secondary topic of interest in the present study is how meaningfulness affects learning and memory when the materials are presented in different modalities, and whether any interactions emerge as a function of people's preferred modalities. Schulz and Hopkins (1968) found that learning of materials that were high in meaning was unaffected by mode of presentation, but materials that were low in meaning were learned faster when presented visually. On the other hand, Rae (1979) discovered that even though visual presentation led to better recall than did auditory presentation, and more meaningful items were remembered more often than less meaningful ones, there was no interaction between meaningfulness and presentation modality. Newcomer and Goodman (1975) stated that meaningfulness of the materials did not interact with learning styles, either.

In this study, we examine the effect of presentation modality and meaningfulness on musicians' and nonmusicians' ability to learn and remember melodies. We also examine whether similar results emerge with verbal materials and how preferred learning styles relate to learning and remembering both types of materials.

EXPERIMENT 1

Method

Participants

From an initial pool of 46 adults, 40 participants were selected because they met the musical-experience and music-learning-style criteria we had specified for this experiment. Participants were American University students who received extra credit toward psychology classes and nonstudents (staff and friends of the first author) who participated on a voluntary basis. Musical experience was assessed by a self-report questionnaire given at the end of the session about the participants' musical background, including their ability to read music, as well as whether they had had any formal training (such as private lessons, attending a conservatory, or taking classes such as harmony or ear-training in school) or played any musical instruments or sang. Half the participants had had less than 2 years of training (we classified these as nonmusicians), and the other half had had at least 5 years of training and reported that they knew how to read music (we classified these as musicians for purposes of this study). Learning style was assessed by the Barsch Learning Style Inventory (BLSI), also given at the end of the session. BLSI is a self-administered questionnaire designed by Barsch (1980) to help people identify whether a visual or an auditory method of learning is more effective for them. This inventory was selected because it exclusively measures individual preferences of the visual and auditory learning modalities and has been used successfully in previous studies (e.g., Davis, Nur, & Ruru 1994). Ten nonmusicians and 11 musicians were classified as auditory learners, and 10 nonmusicians and 9 musicians were classified as visual learners.

Materials

The musical stimuli were 16 excerpts of unfamiliar melodies selected from an ear-training and dictation book (Berkowitz, Fontrier, & Kraft, 1986). They were designated as "longer" or "shorter." The longer melodies were four bars long, and the shorter melodies were their two-bar subsets. The items were further divided into meaningful and less meaningful types based on criteria such as whether they were following or breaking conventional rules or fulfilling or violating expectations (cf. Meyer, 1956). The latter type was prepared by taking a group of four longer melodies and interchanging the notes contained within the individual bars of each melody. Thus, the second bar of Melody 1 replaced the third bar of Melody 2 and the third bar of Melody 2 replaced the second bar of Melody 1, and so on. The shorter, less meaningful melodies were the 2-bar versions of these longer melodies.

The verbal stimuli were 16 unfamiliar sentences obtained from those used by Miller and Isard (1963). Again, they were designated as longer or shorter. The shorter sentences ranged from 5 to 7 words. The longer sentences were combinations of two sentences, thus ranging from 10 to 14 words. Meaningfulness was varied in the same way as with the melodies. We took groups of four sentences, all with similar phrase structure, and interchanged words between the sentences to create grammatical but semantically anomalous sentences, which we called the less meaningful sentences (cf., Miller & Isard). Again, the shorter, less meaningful sentences were the one-sentence versions of their longer counterparts (see Figure 1 for examples of both musical and visual stimuli).

All items were prepared for both visual and auditory presentation. For visual presentation of music, the score was shown on a 15-inch computer monitor; the sentences were also shown on the computer and had the same size and color font against a plain white background. For auditory presentation of music, Noteworthy Composer, a computer software program designed for music processing, was used, and each excerpt was played using the "piano" setting and saved in .wav format for easy playback via a PowerPoint presentation. The sentences were spoken by a woman at a rate of approximately two words per second and recorded in .wav format, as well. For all visually presented items, presentation time was determined by the amount of time it took to auditorily present the same item. Thus, an item that took 4 seconds to play or say auditorily was presented on the screen for 4 seconds visually.

Design and Procedure

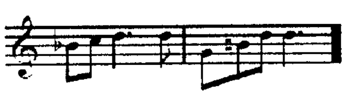
Each participant was presented with 32 items, 16 melodies and 16

Hard—Meaningful

Easy—Meaningful

Hard—Less Meaningful

Easy—Less Meaningful



Hard—Meaningful

Romantic poetry describes eternal love. The frenzied Latin rhythm aroused passions.

Easy—Meaningful

Romantic poetry describes eternal love.

Hard—Less Meaningful

Romantic chaos saves baseball love. The frenzied humid ingredient signed passions.

Easy—Less Meaningful

Romantic chaos saves baseball love.

Figure 1. Examples of Musical and Verbal Stimuli.

sentences. Presentation modality was counterbalanced such that for half of the participants, 8 melodies and 8 sentences were presented auditorily, and the other 8 melodies and 8 sentences were presented visually, and vice versa for the other half of the participants. Meaningfulness was also counterbalanced such that half the participants in each presentation modality group received 8 of the melodies and sentences in their meaningful versions and the other 8 in their less meaningful versions, and vice versa for the other half of the participants. Finally, length was also counterbalanced such that half of the participants in each presentation modality and meaningfulness group were presented with half (4) of the melodies and sentences in their longer version and the other half (4) in their shorter version, and vice versa for the other half of the participants. In this way, across 8 participant groups, all materials were tested in both presentation modalities, meaningfulness conditions, and length conditions equally often.

The participants were tested individually. During the study phase, the materials were always presented in the same order, but in a mixed fashion with respect to type of material (melody or sentence), mode of presentation, meaningfulness, and length. Participants saw or heard each item and then were asked to learn it to criterion. Criterion was defined as error-free recall twice in a row. For recall of visually presented items, participants wrote the notes on a blank sheet of staff paper and the sentence on a blank sheet of lined paper. If they reproduced the item correctly on the first try, the correct version was covered with a piece of paper and they were then asked to reproduce it again; if they did so again correctly, the next item to be learned was presented. For recall of auditorily presented items, participants hummed the melody or spoke the sentence again, both twice in a row.

During oral recall, the experimenter, an experienced musician, had the printouts of all the materials and thus could read along with the recall attempts to determine accuracy. In addition, all responses were taped to allow for additional assessments of accuracy if needed. If participants made even a single mistake, the item was presented again, and they were asked to reproduce again, in the same manner. This followed until the participants were able to correctly recall each item twice without a mistake, or if four unsuccessful attempts had been made, a score of 5 was assigned (although the item was not presented for a fifth time), and the experimenter moved on to the next item. Learning efficiency was defined as the number of trials needed to reach criterion. The session ended with the completion of the two questionnaires.

Results and Discussion

The results are summarized in Table 1. A 2 (Material Type) × 2 (Presentation Modality) × 2 (Meaningfulness) × 2 (Length) × 2 (Learning-Style Preference) × 2 (Musicianship) mixed analysis of variance (ANOVA) with repeated measures on the first four factors showed that, overall, learning efficiency did not vary as a function of

Table 1
Mean Number of Presentations (1–5) Needed for Learning in Experiment 1 as a Function of Presentation Modality, Meaningfulness, and Length for Musicians and Nonmusicians with Visual or Auditory Learning Style Preferences

	Auditory Presentation				Visual Presentation				Overall Modality		Overall Meaning		Overall Length	
	Meaningful		Less Meaningful		Meaningful		Less Meaningful		Auditory	Visual	More	Less	Short	Long
MUSIC	Short	Long	Short	Long	Short	Long	Short	Long						
Auditory Preference														
Musician	1.27	2.27	1.82	4.09	1.95	3.23	2.95	4.68	2.36	3.20	2.18	3.39	2.00	3.57
Nonmusician	1.85	2.90	2.10	3.30	3.10	4.40	2.70	4.50	2.54	3.68	3.06	3.15	2.44	3.78
Visual Preference														
Musician	1.72	3.28	2.83	4.78	1.17	2.17	1.89	3.72	3.15	2.24	2.08	3.31	1.90	3.49
Nonmusician	2.45	4.15	3.00	4.60	1.70	2.90	1.55	2.90	3.55	2.26	2.80	3.01	2.18	3.64
SENTENCES														
Auditory Preference														
Musician	1.14	1.77	1.36	2.68	1.41	2.27	2.09	3.55	1.74	2.33	1.65	2.42	1.50	2.57
Nonmusician	1.10	2.10	1.40	3.05	1.35	2.25	1.85	3.30	1.91	2.24	1.70	2.45	1.43	2.73
Visual Preference														
Musician	1.11	2.50	1.00	3.50	1.11	1.56	1.44	2.56	2.03	1.67	1.57	2.13	1.67	2.53
Nonmusician	1.15	3.00	1.40	4.00	1.15	1.75	1.30	2.30	2.39	1.63	1.76	2.25	1.25	2.76

whether the materials were presented visually or auditorily, $F(1, 36) = 0.98$, $MSe = 0.48$, $p > .10$. Given that we had about equal numbers of visual and auditory preferred learners, it was not surprising that one modality did not lead to superior performance over the other.

When the data for the musical and verbal materials were analyzed separately, indeed there were significant interactions between presentation modality and learning-style preference, $F(1, 36) = 152.56$, $MSe = 0.57$, with melodies, and $F(1, 36) = 110.18$, $MSe = 0.19$, with sentences, both ps < .01. The 2 (Presentation Modality) × 2 (Learning-Style Preference) ANOVAs showed that participants who were classified as visual learners learned the visually presented melodies and the visually presented sentences faster than their auditorily presented counterparts, Fs (1, 38) = 12.64 and 41.39, MSes = 0.24 and 0.10, respectively, both ps < .01, and those who were classified as auditory learners learned the auditorily presented melodies and the auditorily presented sentences faster than their visually presented counterparts, Fs (1, 38) = 34.64 and 18.54, MSes = 0.12 and 0.08, respectively, both ps < .01. Thus, specific learning-style preferences were maintained across the two different types of materials.

As expected, there was a significant main effect for length: Shorter melodies and sentences were learned faster than longer ones, Fs (1, 36) = 471.07 and 687.88, MSes = 0.37 and 0.20, respectively, both ps < .01 (cf. Martin & Roberts, 1967). There was also a significant main effect for meaningfulness: More-meaningful melodies and sentences were learned faster than less-meaningful ones, Fs (1, 36) = 143.81 and 163.50, MSes = 0.26 and 0.20, respectively, both ps < 0.01. There was also a significant interaction between musicianship and meaningfulness of the music, $F(1, 36) = 87.49$, $MSe = .26$, $p < .01$. Musicians learned the meaningful melodies significantly faster than nonmusicians, $F(1, 38) = 40.03$, $MSe = 0.16$, $p < .01$, but nonmusicians learned the less meaningful melodies faster than musicians, $F(1, 38) = 7.85$, $MSe = 0.01$, $p < .01$. With sentences, because both groups had the same level of experience with the English language, there was no interaction between musicianship and meaningfulness, $F(1, 36) = 0.21$, $MSe = 0.20$, $p > .10$.

Interestingly, although there was no interaction between musicianship and length, $F(1, 36) = 1.64$, $MSe = 0.37$, $p > .10$, there was indeed a significant second-order interaction among meaningfulness, length, and musicianship, $F(1, 36) = 8.98$, $MSe = 0.18$, $p < .01$. A breakdown of this interaction into two 2 (Length) × 2 (Musicianship) ANOVAs on the two levels of meaningfulness gave more clarity to this interaction. Meaningful, shorter items were learned faster than longer items, $F(1, 38) = 180.24$, $MSe = 0.18$, $p < .01$, and there was no interaction between length and musicianship, $F(1, 38) = 0.36$, $MSe = 0.18$, $p > .10$. With less meaningful items, however, there was again a similar main effect for length, $F(1, 38) = 640.64$, $MSe = 0.92$, $p < .01$, but this time there was also an interaction in that this effect varied as a function of musicianship, $F(1, 38) = 11.60$, $MSe = 0.92$, $p < .01$. A one-way ANOVA showed that with less

Meaningful Music Excerpts

1 (Target)

2 (Lure)

3 (Lure)

Less-Meaningful Music Excerpts

1 (Lure)

2 (Target)

3 (Lure)

Meaningful Sentences

1. Romantic poetry describes endless love. (Lure)
2. Romantic poetry describes everlasting love. (Lure)
3. Romantic poetry describes eternal love. (Target)

Less-Meaningful Sentences

1. Romantic chaos save baseball love. (Lure)
2. Romantic chaos saves baseball love. (Target)
3. Romantic chaos saved baseball love. (Lure)

Figure 2. Examples from Recognition Tasks

Table 2

Percentage of Items Remembered in Experiment 2 as a Function of Presentation Modality and Meaningfulness for Musicians and Nonmusicians with Auditory or Visual Learning Style Preferences

	Auditory Presentation		Visual Presentation		Overall Modality		Overall Meaningfulness	
	Meaningful	Less Meaningful	Meaningful	Less Meaningful	Auditory	Visual	More	Less
MUSIC								
Auditory Preference								
Musician	96.7	73.3	63.3	33.3	85.0	48.3	80.0	53.3
Nonmusician	78.8	87.9	57.6	57.6	83.3	57.6	68.2	72.7
Visual Preference								
Musician	81.0	47.6	95.2	78.6	64.3	86.9	88.1	63.1
Nonmusician	51.9	44.4	81.5	85.2	48.1	83.3	66.7	64.8
SENTENCES								
Auditory Preference								
Musician	100.0	76.7	76.7	56.7	88.3	66.7	88.3	66.7
Nonmusician	100.0	78.8	78.8	54.6	89.4	66.7	89.4	66.7
Visual Preference								
Musician	81.0	61.9	92.9	85.7	71.4	89.3	86.9	73.8
Nonmusician	92.6	44.4	88.9	85.2	68.5	87.0	90.7	64.8

meaningful items, musicians were at a disadvantage when they were longer, $F(1, 38) = 18.01$, $MSe = 0.14$, $p < .01$, but not when they were shorter, $F(1, 38) = 0.10$, $MSe = 0.14$, $p > .10$.

EXPERIMENT 2

The purpose of Experiment 2 was to see whether the variables that led to differences in learning (as measured by the number of trials taken to reach a certain criterion) in Experiment 1 would also lead to differences in memory (as measured by success in subsequent recognition tests).

Method

Participants

Forty-four adults were selected from a pool of 67 participants in the same way and using the same criteria as in Experiment 1. Of these, 20 were nonmusicians and 24 were musicians. In addition, 10 musicians and 11 nonmusicians were auditory learners, and 14 musicians and 9 nonmusicians were visual learners. None had participated in Experiment 1.

Materials

There were 12 melodies and 12 sentences, varying in presentation modality and meaningfulness. In this experiment, length was no longer a variable of interest, and we used those items from Experiment 1 that took at most two trials to learn and were thus the "easiest" materials. An additional set of 24 melodies and 24 sentences was constructed to serve as lures in a three-alternative forced-choice recognition test, and these melodies and sentences were yoked with their respective targets. For melodies, the lures were variations of the targets in that we altered one random note (other than the first or last note) by moving it up or down several steps. For sentences, the lures had the same structure and meaning as the targets, but one or two of the words were replaced with semantically related ones (see Figure 2 for examples).

All materials were presented via a laptop computer running PowerPoint and connected to an external television monitor. For the recognition test, participants were given answer sheets and asked to circle correct answers. For visually presented items, the target and two lures were printed on the answer sheet, and participants circled the item they believed to be correct. For the auditorily presented items, the words "Number 1," "Number 2," and "Number 3" were printed on the answer sheet. After hearing all three choices, participants circled the number corresponding to the item they believed to be correct. In addition, as in Experiment 1, participants were given the BLSI and the music questionnaire.

Design and Procedure

The 24 target items were divided into three blocks of 8 items each. The reason for dividing the items into blocks rather than presenting all items at once was to avoid floor effects in the memory test. In each block, there were two melodies presented visually, two melodies presented auditorily, two sentences presented visually, and two sentences presented auditorily.

Presentation modality was counterbalanced such that melodies and sentences presented visually for one group were presented auditorily for another group. Meaningfulness was also counterbalanced such that, in each block, the two melodies and two sentences presented in their meaningful format for one subgroup of participants were presented in their less meaningful format for the other subgroup. Thus, across four groups of participants, each melody and sentence was presented in the visual and auditory conditions as well as the meaningful and less meaningful conditions equally often. The order in which the items were presented within each block was randomized with respect to type of material, modality of presentation, and meaningfulness.

Participants were tested in groups of up to eight people at a time. They were presented with the first group of eight items and asked to memorize them in preparation for a future memory test. Each item was presented only once. Visually presented items remained on the screen for as long as their auditory presentation would have taken; thus, for example, a melody that took 4 seconds to play auditorily remained on the screen also for 4 seconds. Following the presentation of each item, there was a blank screen or silence that lasted as long as the presentation of the actual stimulus, serving as an interstimulus interval. Thus, a melody that was presented for 4 seconds was followed by an interstimulus interval of 4 seconds. Participants were instructed to use this interval as a study period or extra time to memorize the item they had just seen or heard.

Immediately following the presentation of each block, participants were given a three-alternative forced-choice recognition test for the eight items just presented. Each stimulus was tested in the same modality in which it had been presented, although the testing order was different from the presentation order. Of interest was probability of correct recognition. Participants were given as much time as necessary to answer each item. Once the recognition test for the third block was completed, participants were given the BLSI and the music questionnaire.

Results and Discussion

The results are summarized in Table 2. Paralleling the results in Experiment 1, there was no main effect of presentation modality, $F(1, 40) = 0.185$, $MSe = 308.58$, $p > .10$, and there was a significant interaction between presentation modality and learning-style preference,

F (1, 40) = 125.44, MSe = 308.58, $p < .01$. The results of the 2 (Presentation) × 2 (Learning-Style Preference) ANOVAs indicated that auditory learners were better at remembering auditorily presented melodies and sentences, Fs (1, 42) = 32.74 and 30.90, MSes = 229.46 and 210.64 respectively, both ps < .01, and visual learners were better at remembering visually presented melodies and sentences, Fs (1, 42) = 54.49 and 29.19, MSes = 210.63 and 177.69, respectively, both ps < .01.

We also found main effects for meaningfulness for both melodies and sentences, Fs (1, 40) = 26.45 and 48.58, MSes = 242.87 and 383.52, respectively, both ps < .01. Moreover, although musicians and nonmusicians did not differ in the number of melodies they remembered, F (1, 40) = 0.76, MSe = 517.70, $p > .10$, there was again a significant interaction between musicianship and meaningfulness, F (1, 40) = 32.58, MSe = 242.87, $p < .01$. The results of a 2 (Meaningfulness) × 2 (Musicianship) ANOVA revealed that musicians remembered more of the meaningful melodies than nonmusicians did, F (1, 42) = 18.27, MSe = 177.15, $p < .01$, but nonmusicians remembered more of the less meaningful melodies than musicians did, F (1, 42) = 5.22, MSe = 215.06, $p < .01$. Again, because both groups were equally proficient in English, there were no differences between musicians' and nonmusicians' ability to remember sentences, F (1, 40) = 1.35, MSe = 383.52, $p > .10$. These results mirror those found in Experiment 1, this time in the domain of memory rather than learning.

GENERAL DISCUSSION

Studies addressing the influence of presentation modality in learning and memory have produced conflicting results. Some have shown visual presentation to be more beneficial (e.g., Izawa et al., 1980), and others have shown auditory presentation to be more beneficial (e.g., Moreno & Mayer, 1999). More important, presentation in one's preferred learning style, for present purposes defined as a preference for a particular perceptual modality (auditory or visual) in organizing and processing information (Riding & Read, 1996), has been shown to lead to more efficient learning and better memory for the materials (e.g., Stahl, 1999). In this study, we found that with music, too, both learning efficiency and recognition memory were better when the materials were presented in a person's preferred presentation modality.

Tailoring teaching to students' dominant or preferred learning styles is already an established instructional approach with verbal materials (e.g., Ingersoll, 1974; Lilly & Kelleher, 1973; Threadgill-Sowder & Sowder, 1982). In examining methods of teaching music using different perceptual modalities (e.g., Brathwaite, 1988; Kendall, 1988), however, more often the emphasis has been on finding out whether one method is superior to another in general. An important implication of our results for teaching of music is that, just as with verbal materials, music teachers may increase their success by concentrating initially on the type of teaching that focuses on a student's preferred learning style. Even though music is intrinsically "auditory," especially for nonmusicians who are not proficient music readers, auditory or visual learning styles still play a role in effective learning and subsequent remembering. Moreover, we found that this relationship between presentation modality and preferred learning style appears not to be material-specific but an overarching preference, suggesting a general cognitive strategy preference. Thus, observed dominance of one modality with one material type can help determine also how other types of materials could be taught.

Not surprisingly, paralleling results found with verbal materials (e.g., Martin & Roberts, 1967), participants learned shorter melodies faster than longer melodies. Interestingly, however, there was a three-way interaction among musicianship, length, and meaningfulness. Musicians were faster when learning the meaningful melodies, both shorter and longer, but nonmusicians were faster when learning the longer, less meaningful melodies. One explanation could be that with longer and less-meaningful materials there was a processing-storage trade-off resulting from working memory limitations as a consequence of time constraints, resource-sharing processes, and cognitive load (Barrouillet, Bernardin, & Camos, 2004). Cognitive load is defined by the mental power necessary to complete a task, and the more components requiring attention and processing inherent in a task, such as length, meaningfulness, or familiarity, the more taxing the task becomes. In the present study, with less meaningful melodies and the added component of length, perhaps the processing was particularly taxing for participants, going beyond their working memory capacities. That is, for meaningful melodies, musicians' prior knowledge about music facilitated learning, but when engaged in an extra task of attempting to make sense of the items, musicians seemed overloaded and performed less well, at least in this study where being classified as a musician did not require extensive training.

As expected, less meaningful sentences were learned more slowly and remembered less often than their more meaningful counterparts (e.g., Epstein, Rock, & Zuckerman, 1960). One general explanation is that less meaningful materials may be altered so that they can fit within an existing schema, either during learning (construction) or during remembering (reconstruction), leading to memory errors (e.g., Bartlett, 1932; Miller & Isard, 1963). The same likely applies to the way participants, especially those with musical backgrounds, learn and memorize musical stimuli.

Similarly, it is often a schema-based framework that is used to explain differences in expert and novice learning (Kalyuga, Ayres, Chandler, & Sweller, 2003). Experts' use of domain-specific schemas leads to the use of effective organizational or constructive strategies for learning materials from within that specific domain. If the information is incongruent with an expert's schema, however, processing requires more cognitive effort, because the expert is not only attempting to learn it, but also attempting to make the material somehow fit the schema. Thus, in the present study, when subjects were given less meaningful music excerpts, these very same schemas were also what most likely hindered learning and remembering, because of the additional task of trying to make sense of the excerpt (cf. Baird, 2001). The absence of these schemas led to lower learning performance on the part of these "novices" but, by the same token, did not lead to the interference experienced by the "experts" with less meaningful excerpts.

In conclusion, it seems that although expertise is beneficial when attempting to learn and remember music that is meaningful, it can be detrimental when the materials take on a less meaningful arrangement. In addition, there appears to be a relationship between learning style preferences and how efficiently and successfully people learn and remember not only verbal materials, but musical materials as well. Thus, music teachers may find it beneficial to consider students' preferred learning styles when planning music instruction, particularly when the intended outcomes involve the learning and memorizing of melodies.

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Submitted October 5, 2005; accepted September 28, 2006.