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Timbre Reliance in Nonmusicians' and Musicians' Memory for Melodies

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This paper reports two experiments that test Wolpert's' (1990) claim that musicians and nonmusicians differ in their memory for melodies because nonmusicians' memory performance reflects a greater use of the timbre dimension to make recognition decisions. In both experiments, listeners were asked to identify which of two test melodies, a target and a distractor, was heard previously. On one half of the trials, the target melody was in the same timbre as the original, and the distractor was in a different timbre. For the other half of the trials, the distractor melody was in the same timbre as the original, and the target melody was in a different timbre. In her earlier study, Wolpert found that nonmusicians' memory for melodies was affected by timbre changes, whereas musicians' memory was not. In the present experiments, we controlled for instruction clarity and brought listener performance down from near perfect. As a result, it was found that timbre changes differentially affected neither musicians' nor nonmusicians' memory for melodies.

MUSICIANS have more experience and greater involvement with music than nonmusicians. This much is obvious. However, the manner in which musicians and nonmusicians differ in their mental representation and processing of music remain largely unexplored. This paper is concerned with how musicians and nonmusicians differ in their memory for melodies. By looking at such individual differences, we can investigate both which aspects of a melody are considered more important by the listener and how a listener has organized and structured the music. Generally speaking, as compared with novices, experts are better able to select the relevant features of a stimulus and then chunk the information in memory, allowing them to remember more overall (e.g., Chase & Simon, 1973; Lesgold, Rubinson, Feltovich, Glaser, Klopfer, & Wang, 1991; Myles-Worsley,

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Johnston, & Simons, 1988). Therefore, one would expect nonmusicians, as compared with musicians, to show a greater inability to use structural features and a greater reliance on surface features in their memory for melodies. In the present context, the term *structural features* refers to those aspects of music that are not directly represented in a sound signal, but are interpreted on the basis of a person's (often implicit) musical knowledge. This would include such things as musical key and harmonic progression. The term *surface features* refers to those aspects of music that are carried directly by a sound signal, such as timbre and pitch height. Surface features are less relevant to melody because changing these is less likely to change the actual melody. So, based on this perspective, musicians would be assumed to be better able to focus on central aspects of a piece of music, allowing them to better structure their mental representation of it.

There is some evidence in the psychomusicological literature supporting this notion (Beal, 1985; Cuddy & Cohen, 1976; Pitt, 1994; Wolpert, 1990). In those studies, musicians outperformed nonmusicians on tasks investigating memory for musical excerpts. However, there is also some evidence that suggests that musicians' and nonmusicians' memory for music is very similar in all but the most complex aspects of music (Halpern, 1984; Russell, 1987; Serafine, Glassman, & Overbeeke, 1989; Sloboda & Parker, 1984). In these latter studies, musicians and nonmusicians performed equivalently on music identification tasks. So, although musicians have a capacity to outperform nonmusicians on some memory tasks, they do mentally represent music similarly at a basic level. What is unclear is precisely the manner in which these two groups differ.

One of the most fundamental changes that can occur in a musical item is a change in timbre (e.g., Hartmann & Johnson, 1991). A change in timbre in a piece of music is often a signal that a new structural unit is being presented. Given such a blatant surface feature change, if nonmusicians are overreliant on surface features in their memory for melodies, then they should be more error prone on a memory task. This could be true either because they interpret the timbral change as a change in melodic structure or because they are simply less able to separate the pitch pattern from the timbre in which it was originally played. So, in a melody recognition task, nonmusician listeners may fail to recognize a melody as previously heard when such an alteration is made.

One source of support for musician and nonmusician differences in music perception involving timbre is a study by Pitt (1994). In one experiment, nonmusician listeners were less accurate in identifying when two tones differed in pitch when the tones were in different timbres than when they were in the same timbre. Musicians were near perfect on this task. In general, it has been found that people find it very difficult to attend to the pitch dimension while ignoring the timbre dimension when that dimension is varied (Krumhansl & Iverson, 1992; Melara & Marks, 1990). In a second experiment, using a Garner interference paradigm with pitch and timbre dimensions, Pitt observed that musicians were better able to separate out these dimensions than nonmusicians.

Another source of support for the hypothesis that there exists a difference between musicians' and nonmusicians' memory for music comes from a study by Beal (1985) using a chord discrimination task. Listeners were presented with pairs of chords and were asked to indicate whether the second chord was the same as the first. The second chord was either the same or a different chord and was in the same or a different timbre than the first chord. Performance between the groups was similar when the chords were different, the timbres were the same, or when the stimuli were not typical diatonic chords. Furthermore, the two groups did not substantially differ in their ability to discriminate timbres. However, Beal found that musicians outperformed nonmusicians when the same chord was played in different timbres. Nonmusicians produced more errors when there was a timbre switch, even though the chord was unaltered.

Although these results seem to support the notion that nonmusicians and musicians use timbre information differently in their memory for music, it is difficult to extend these results to memory for melodies. The results of these studies are based on pairs of tones or chords, not complete melodies. It is generally accepted that people interpret melodies not as a series of specific tones, but more as a contour of pitch intervals, not to mention all that is involved with the interpretation and representation of rhythm. So, it is possible that these results may not generalize to memory for entire melodies.

In a direct comparison of musicians' and nonmusicians' memory for whole melodies, Wolpert (1990) used a matching-to-sample recognition task. On each trial, a familiar melody (e.g., "Twinkle, Twinkle, Little Star") was played in a given timbre, such as on a piano or an oboe. After the melody was played, two test melodies were presented. One test melody, a *target* melody,[1] was the same as the original melody, whereas the other test melody, a *distractor* melody, was different (e.g., "Hot Crossed Buns"). The listeners' task was to select the test melody that most closely resembled the origi-

1. It should be noted that we use different terms than Wolpert (1990) to describe the melodies in our experiments. In particular, what refer to as the "original" melody was called the "model" by Wolpert. We believe that our term more directly reflects the fact that this was the original melody heard that was to be identified later, not a model from which the subsequent melodies were derived. Furthermore, what we refer to as "target" and "distractor" melodies were called the correct and incorrect "choices." Again, we believe that our terms more directly convey the nature of these choices.

nal. One test melody was in the same timbre as the original, whereas the other was in a different timbre. On one half of the trials, the target melody was in the same timbre as the original, whereas the distractor was in a different timbre. In contrast, for the other half of the trials, the distractor was in the same timbre as the original and the target melody was in a different timbre. Wolpert found that musicians were highly accurate in identifying previously heard melodies (100% scored perfectly), whereas nonmusicians were less accurate (52% scored perfectly). These data suggest that the nonmusicians tended to make their recognition judgments on the basis of timbre similarities, rather than by identifying the previously heard melody. Consequently, musicians appear to be more sensitive to the underlying structure of a melody, whereas nonmusicians appear to be more sensitive to surface features (i.e., timbre).

However, a criticism of Wolpert's (1990) investigation is that the instructions given to the listeners were vague. They did not specify on what basis the recognition judgment should be made. In particular, listeners were told to select the option that "most resembled the model." Although Wolpert intentionally left the instructions vague so "that the instructions did not direct the subjects' attention to any one aspect of the music, nor in any way make clear the musical assumptions of the culture" (p. 102), musicians may have interpreted this instruction as referring to the melodies, whereas nonmusicians may have interpreted this as referring to timbres. As a consequence, Wolpert's data may reflect different interpretations of the instructions by nonmusicians and musicians, not differences in the mental representation or understanding of the music (for a discussion of similar concerns, see Cook, 1994).

Another criticism of the results reported by Wolpert (1990) is that the performance of the musicians was perfect. When performance by a group of listeners is at such a high level, there is no room for any variability. Specifically, because memory performance is so high, with no errors, there is no way to assess how the information might be mentally represented. As such, it is impossible to determine whether recognition can be influenced by timbre.

The current experiments explored how music is mentally represented by comparing musicians and nonmusicians. In particular, these studies more carefully examined the influence of Wolpert's vague instructions on the memory test. Furthermore, efforts were made to bring listener performance down from near perfect by using less well known melodies and by including a filled retention interval between the original and test melodies to discourage active rehearsal of the melodies and encourage some forgetting. Experiment 1 used only nonmusicians to test the effect of instruction specificity. In Experiment 2, the performance of musicians and nonmusicians was directly compared using less vague instructions on a melody recognition task.

Experiment 1

Experiment 1 was a replication and extension of a study by Wolpert (1990). Listeners were presented with a melody and then later asked to identify which of two alternatives corresponded to the original melody. One of the options was in the same timbre as the original (e.g., piano) whereas the other was in a different timbre (e.g., violin). On half of the trials, the target melody was in the same timbre as the original, whereas the distractor was in a different timbre. We refer to these as *Match* trials. On the other half of the trials, the target melody was in a different timbre than the original, whereas the distractor was in the same timbre as the original. We refer to these as *Mismatch* trials. Wolpert found in her study that nonmusicians made numerous errors on Mismatch trials, whereas musicians were error free.

Experiment 1 used Wolpert's (1990) original procedure with four modifications. First, we varied the type of instructions the listeners received. In her study, Wolpert was concerned with not guiding the listeners' judgments too much; therefore, she deliberately gave ambiguous instructions, telling her listeners to choose the melody that "most resembled" the original. We thought that her instructions may have been too vague, the result of which may have been that musicians and nonmusicians used different criteria as the basis for their judgments. As such, an adequate test of musical memory would not have been given. To investigate this issue, we gave half of our listeners Wolpert's instructions, and the other half a modified set of instructions that were less ambiguous. The unambiguous instructions conveyed that memory for the *melody* was important. Specifically, listeners in the unambiguous group were told to choose the option that was "melodically most similar" to the original melody. If instructions are important in orienting listeners to different characteristics of the melodies, then those listeners who receive ambiguous instructions should have poorer memory performance than listeners who receive unambiguous instructions.

As mentioned earlier, one of the problems with Wolpert's (1990) original study was that performance for some listeners, namely the musicians, was nearly perfect. So, two steps were taken here to make the task more difficult. The second change to Wolpert's original procedure was the use of lesser known melodies, rather than well-known tunes. If the effect reported by Wolpert is real, we would expect it to be exaggerated given unfamiliar stimuli because our listeners would have even less previous knowledge of the melody to use in making their recognition decisions. Third, we included a 30-s retention interval between the original and test melodies.[2] During the retention interval, listeners were asked to count backwards from a three-digit number by some interval ranging from three to seven.

Finally, only nonmusicians were tested in Experiment 1. Nonmusician listeners were defined as people having 5 years or fewer of formal experience with an instrument. Only nonmusicians were tested because only the nonmusicians' data had shown an influence of timbre switch in Wolpert's study, and the critical manipulation of the present study was how the type of instructions would influence this effect.

METHOD

Listeners

Thirty-two nonmusicians were drawn from the subject pool at the University of Notre Dame and received partial course credit for their participation. These people were between 18 and 22 years old (M = 19.6 years old, SD = 1.3 years). Our listeners had played an instrument from 0 to 5 years (M = 1.6 years, SD = 1.8 years); 31 were not currently playing an instrument. None had any formal training in music theory. Listeners reported spending 1.5–40 hr/week (M = 11.6 hr/week, SD = 9.5 hr/week) listening to music.

Apparatus

The study was conducted on a 486DX PC-compatible computer equipped with Soundblaster 16-bit ASP and Waveblaster sound cards, which ensured sufficient control of the production of the melodies as well as the generation of reasonably high quality sounds. The melodies were amplified by a Fostex PH-5 headphone amplifier and presented over Sony MDR-7506 headphones.

Melodies

The melodies used in both experiments were chosen from *Easy Classics to Moderns* (Agnay, 1956), a book of relatively simple piano tunes. These melodies were selected both for their simple structure and because they were less well known than the tunes used by Wolpert (1990). Only the melody lines were used. A complete list of the 16 melody pairs appears in the Appendix.

The 64 melodies were grouped into 32 pairs. The melodies in each pair were matched as closely as possible on a number of dimensions. Each melody pair had the same time signature, mode (major or minor), key, and tempo. Typically, paired melodies were originally written in different keys; therefore, transposition of one of the melodies was necessary so that it matched the key of the other. Melodies were about 8 measures long, with the exception of melodies with a $\frac{2}{4}$ time signature, which were 16 measures long. All melodies ended at the appropriate phrase ending. The tempo for each melody pair was determined by averaging the tempi designated for the two melodies in the scores.

Additional characteristics of the pairs of the melodies were that the pitch range between the melodies differed by 0–12 half steps (M = 2.5 half steps, SD = 2.6 half steps), deviated from each other in the number of accidentals by 0–7 (M = 1.4 accidentals, SD = 1.7

2. A pilot experiment revealed that listener performance was near perfect when no retention interval was included.

accidentals), and varied in the number of rests by 0–5 (M = 1.0 rest, SD = 1.6 rests). Although most melody pairs were the same in terms of the shortest and longest note values, 2 melody pairs differed in the length of the shortest note value, and 10 differed in the length of the longest note value (e.g., a quarter note versus a dotted quarter note). These deviations were largely confined to brief sections of the melodies.

The timbres used were selected from the Waveblaster's bank of digitally sampled sounds. These timbres were acoustic grand piano, violin, trumpet, oboe, flute, electric guitar (clean), vibraphone, and Hammond organ. Because 32 melody pairs were used in the experiment, 24 of the timbre combinations were used once, and four were used twice across the melody pairs. The assignment of a particular timbre combination to a melody pair, as well as the melodies within that pair, was randomly determined. The melodies were encoded into the computer as MIDI files. The melodies were played at a constant dynamic and did not possess any timing irregularities.

Procedure

At the beginning of each session, listeners filled out a musical history questionnaire. This questionnaire asked about any significant prior experience in music performance or theory. Listeners were randomly assigned to either the ambiguous or unambiguous instruction group depending on when they arrived at the laboratory. Ambiguous instructions were derived from the wording reported by Wolpert (1990) and stated that listeners should select the option that "most resembled" the original. Unambiguous instructions were identical to the ambiguous instructions, with the exception that it was stated that listeners should select the option that was "melodically most similar to" the original.

Across all trials, the order of the target and distractor melodies was counterbalanced. For half the trials, the target preceded the distractor, for the other half, the distractor preceded the target. Furthermore, within each presentation order, half of the target melodies matched the timbre of the original (Match trials), for the other half, the distractor melodies matched the timbre of the original (Mismatch trials). So, the design of the experiment was a 2 (Instructions) × 2 (Order) × 2 (Match/Mismatch) mixed factorial design. The first variable was between subjects and the other two were within. There were eight trials for each Order-Match/Mismatch combination. The order of presentation was randomized for each listener.

Melodies were presented via headphones at a comfortable listening level. Listeners were able to control the loudness. To initiate a trial, listeners pressed the space bar on the computer. At that time, the phrase "new melody" was displayed on the screen, and a recorded voice stated "melody" over the headphones. After the melody was completed, the distractor task was given during the 30-s retention interval during which listeners saw two numbers on the screen—a three-digit number to the left and a single-digit number to the right. They were asked to count backwards aloud from the number on the left by the interval on the right. For example, if they saw "345" and "3," they would count aloud: "345, 342, 339, etc." They were told to continue until the numbers disappeared from the screen (at 30 s) and the melody options were presented. Listeners were told to count as quickly and as accurately as possible. To encourage accuracy, listeners were told that the experimenter would keep track of any mistakes that were made; however, no actual record was kept. Following the completion of the 30-s retention interval, the listeners saw and heard the words "Option 1" on the screen. Then, the first melody option was played. The same procedure was repeated for "Option 2." After the completion of the second melody, the listener selected their answer by pressing the "1" or "2" buttons on the keyboard. The computer recorded the responses.

Two practice trials were given to familiarize the listeners with the task and to provide them an opportunity to ask questions. The practice trials used the same procedure as the actual test but had different melodies that were easily discriminable. Listener responses on these trials were not recorded.

RESULTS AND DISCUSSION

The data for Experiment 1, collapsed across target-distractor order, are summarized in Figure 1. The error-rate data were submitted to a pair of 2 (Instruction) × 2 (Order) × 2 (Option Type: Target versus Distractor) analyses of variance (ANOVAs). For the listener analysis, the first variable was between subjects and the rest were repeated measures, whereas for the item analysis all of the variables were treated as repeated measures (because all melody pairs were tested under all conditions). The proportion data were arc-sine transformed before being submitted to the ANOVA to correct for deviations from normality. A rejection level was set at $p < .05$ for all analyses. One analysis used listeners as the random variable (subscript 1), whereas the other used melodies as the random variable (subscript 2).

Listeners in Experiment 1 made an average of 19.3% errors on the identification task. As predicted, the data are consistent with a reliance on timbre. More errors were made in the Mismatch condition (55.8%) than the Match condition (21.4%) [$F_1(1,30) = 14.03, MS_e = .094$; $F_2(1,31) = 56.46, MS_e = .042$]. Furthermore, the Instruction × Option Type interactions were significant [$F_1(1,30) = 4.92, MS_e = .094$; $F_2(1,31) = 19.13, MS_e = .038$]. Specifically, the Match/Mismatch difference was greater for the Ambiguous group than the Unambiguous group. Simple effects tests revealed that the Match/Mismatch difference was significant for both the Ambiguous group [$F_1(1,15) = 10.38, MS_e = .161$; $F_2(1,31) = 58.23, MS_e = .049$] and the Unambiguous group [$F_1(1,15) = 4.06, MS_e = .027, p = .06$; $F_2(1,31) = 7.72, MS_e = .031$].

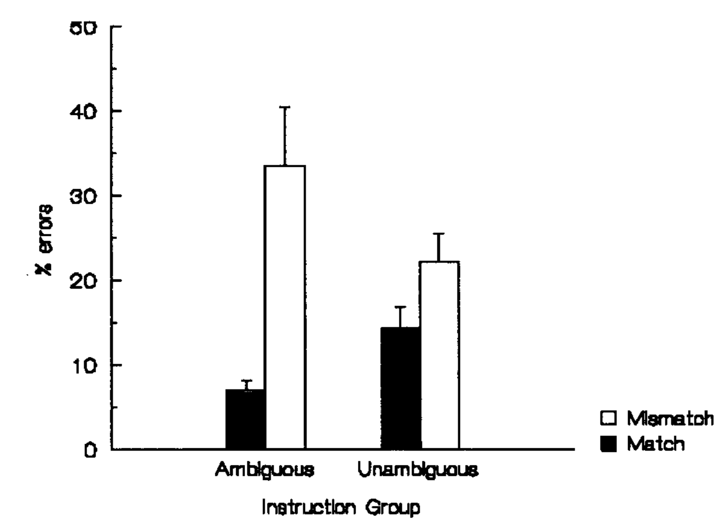

Fig. 1. Error rates with standard error bars for the match and mismatch trials under ambiguous and unambiguous instruction conditions for Experiment 1.

The greater error rate on Mismatch trials revealed that our nonmusician listeners heavily weighted the characteristic of timbre in making their memory judgments. Furthermore, listeners made more errors when given the ambiguous instructions than the unambiguous instructions. This suggests that Wolpert's (1990) instructions may have allowed some listeners to place more emphasis on timbre rather than melody in making their memory judgments. More importantly, both instruction groups in our experiment showed the same error pattern, suggesting that timbre is relied on in making memory judgments and is a substantial component of memory for music, at least for nonmusicians.

Experiment 2

Experiment 2 directly compared musician and nonmusician performance on our memory-for-melodies task. It was expected that musicians would produce fewer errors overall and would be less affected by timbre shifts. Because we were more interested in assessing memory for melodies than the interpretation of ambiguous instructions, only the unambiguous instructions were used in Experiment 2. Nonmusicians were again defined as individuals with 5 years or fewer of experience in playing an instrument, whereas musicians were defined as individuals with 10 years or more of experience.

METHOD

Listeners

Twenty-four musicians were recruited from the University of Notre Dame community and were paid $5 for their participation. They were between 19 and 24 years old (M = 20.3 years old, SD = 1.3 years). Only one musician was not currently playing an instrument. Musicians had played an instrument from 10 to 19 years (M = 12.6 years, SD = 2.3 years) and had 0–4 years (M = 0.8 years, SD = 1.0 years) of formal music theory classes. They reported spending 1–40 hr/week (M = 20.0 hr/week, SD = 11.9 hr/week) listening to music. The data from the 16 nonmusicians of the Unambiguous group from Experiment 1 were used in Experiment 2 along with an additional 8 nonmusician listeners. These additional listeners either received partial course credit or $5 for their participation. Overall, the nonmusicians were between 18 and 22 years old (M = 19.5 years old, SD = 1.3 years). Only 2 of the 24 nonmusicians reported currently playing an instrument. Nonmusicians had played an instrument from 0 to 5 years (M = 1.7 years, SD = 1.9 years) and had no classes in music theory. They reported spending 1.5–35 hr/week (M = 14.2 hr/week, SD = 8.8 hr/week) listening to music.

Apparatus, Materials, and Procedure

The same apparatus, procedure, and materials were used as in Experiment 1. Only the Unambiguous instructions were used.

RESULTS AND DISCUSSION

The data for Experiment 2, collapsed across target-distractor order, are summarized in Figure 2. The arc-sine-transformed error rate data were submitted to a pair of 2 (Group) × 2 (Order) × 2 (Option Type) ANOVAs. Again, a rejection level of $p < .05$ was selected. As predicted, overall, the musicians made fewer errors (4.3%) than the nonmusicians (18.5%) [$F_1(1,46) = 30.08$, $MS_e = .034$, $F_2(1,31) = 109.76$, $MS_e = .012$]. More errors were made on Mismatch trials (14.3%) than on Match trials (8.5%) [$F_1(1,46) = 12.02$, $MS_e = .015$, $F_2(1,31) = 13.98$, $MS_e = .017$]. Finally, there was also a significant Group × Order interaction [$F_1(1,46) = 4.96$, $MS_e = .017$, $F_2(1,31) = 7.85$, $MS_e = .015$]. Specifically, musicians made more errors when the distractor preceded the target (6.5%) than vice versa (2.1%) [$F_1(1,23) = 7.06$, $MS_e = .007$, $F_2(1,31) = 20.13$, $MS_e = .003$], whereas there was no significant difference for the nonmusicians (16.7% and 20.3%, respectively) [$F_1(1,23) = 1.30$, $MS_e = .026$, $p > .20$, $F_2(1,31) = 1.71$, $MS_e = .031$, $p > .20$].

Importantly, the Group × Type interaction was not significant [$F_1 < 1$, $F_2(1,31) = 1.39$, $MS_e = .013$, $p > .20$]. This suggests that both groups were similarly affected by timbre changes. So, although there is an overall performance difference between the musicians and nonmusicians, this difference cannot be attributed to an overreliance on timbre on the part of the nonmusicians.

In summary, as predicted, Experiment 2 revealed that nonmusicians performed worse than musicians on a music memory task. However, although

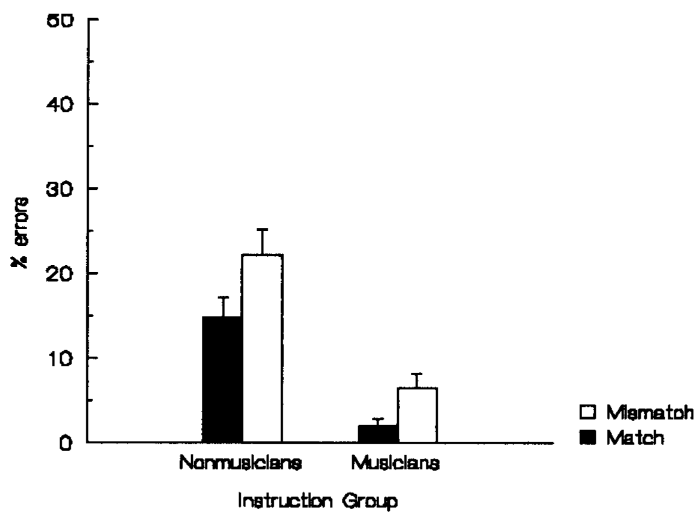

Fig. 2. Error rates with standard error bars for the match and mismatch trials for musician and nonmusician listeners for Experiment 2.

it was expected that musicians' memory for melodies would not be influenced by timbre changes, the data indicate that both groups showed a similar influence of timbre. This suggests that although there is a difference in musicians' and nonmusicians' memory for melodies, this difference is not based on a difference in the reliance on timbre as suggested by Wolpert (1990).

General Discussion

Two experiments were conducted to investigate whether differences in musicians' and nonmusicians' memory for melodies are at least partially attributable to differences in the degree of emphasis on the surface features of a melody in making recognition decisions. Based on research by Wolpert (1990), it was expected that nonmusicians' recognition memory for melodies would be more reliant on timbre than would that of musicians. In her original study, Wolpert reported a substantial difference in musicians' and nonmusicians' memory for melodies. However, these results are suspect because the instructions given to the listeners may have been ambiguous. Furthermore, it is difficult to assess the musicians' memories because their performance was near perfect. In Experiment 1, consistent with the notion that nonmusicians rely on timbre as a means of remembering novel melodies, performance was worse on Mismatch trials where the target melody was in a different timbre than the original and the distractor was in the same timbre. Furthermore, it was also found that Wolpert's (1990) original ambiguous instructions resulted in poorer performance than less ambiguous instructions designed to focus listeners' attention on the melody itself. However, even those listeners who received the unambiguous instructions showed the same pattern of results as the listeners who received the ambiguous instructions—performance was worse on Mismatch trials than Match trials, although the effect was smaller.

In Experiment 2, the performance of musicians and nonmusicians was directly compared. Not surprisingly, musicians performed much better at the identification task than did the nonmusicians. However, despite their overall superior performance, the musicians showed a pattern of errors that was comparable to that of the nonmusicians. For both groups, more errors were made on Mismatch trials than Match trials. This suggests that whatever the source of the difference between musicians' and nonmusicians' memory for melodies, it may not be a difference in the influence of surface features, such as timbre.

These experiments help to clarify the difference between musicians' and nonmusicians' memory for music. Specifically, the results show that, even at very short intervals (i.e., 30 s), people are less able to identify a melody as having been heard before when the instrument on which that melody is played is different from the original. As mentioned earlier, it has been found that people have difficulty differentially attending to pitch and timbre dimensions in memory tasks (Krumhansl & Iverson, 1992; Melara & Marks, 1990; Pitt, 1994). So, consistent with these results, changing such a seemingly integral part of a novel melody (the timbre) would certainly reduce a person's chances of later identifying that melody.

Although the amount of attention paid by the listener to surface features, such as timbre, may not explain the difference between musicians and nonmusicians' memory for music, there is clearly a difference that needs to be accounted for. Based on recent research, some promising possibilities to locate the source of this difference are based more on underlying structures, such as memory for various types of note intervals (Mawhinney, 1987 as reported in Cuddy, 1993), chordal accompaniments (Povel & Van Egmond, 1993), or harmonic structure (Serafine et al., 1989). For example, Povel and Van Egmond reported a study in which listeners' recognition memory for melodies was unaltered when the nature of a chordal accompaniment was changed. Specifically, chordal accompaniment could be (a) added where none had previously existed, (b) removed where there once was one, or (c) changed from one type of accompaniment to another. Their results suggest that their listeners formed a separate representation of the melody that had been abstracted from what had been heard. Furthermore, the listeners in the Povel and Van Egmond study had moderate levels of musicianship, with an average of 6.5 years experience playing an instrument. It could be that people with less experience will be more sensitive to changes in chordal accompaniment. Alternatively, people with more experience may create more elaborate mental representations of a piece of music that include information about accompaniment, and as a result, would be more sensitive to changes in accompaniment.

Another avenue of research that could be pursued is to address the mechanisms responsible for the decrement in memory for melodies in both musicians and nonmusicians when surface features have been altered. Specifically, is the decrement due to processes specific to the processing of music or is it due to more general aspects of human memory? One promising perspective is to look at how changes in surface features, such as timbre or pitch, may bring about source monitoring failures (Johnson, Hastroudi, & Lindsay, 1993) or reflect the forgetting of stimulus characteristics (Riccio, Rabinowitz, & Axelrod, 1994). For example, if the memory decrement is due to source monitoring failures, then it would be expected that similar sorts of deficits would be seen when other features of a tune that denote source information are altered, such as its location in space (e.g., right or left). Conversely, no memory decrement should be observed when a feature that does not denote source is changed, such as transposing a melody. However, more research is needed before these questions can be more confidently addressed.[3]

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Appendix

MELODY PAIRS

"The Wild Horseman" (Schumann)	—	"Tarantella" (Prokofiev)
"Four Landlers" (No. 4) (Schubert)	—	"Minuet" (W. A. Mozart)
"The Reaper's Song" (Schumann)	—	"An Old Romance" (Heller)
"Gavotte" (Turk)	—	"Gavotte and Variation" (Handel)
"Seven German Dances" (No. 5) (Haydn)	—	"Three Country Dances" (No. 3) (Beethoven)
"Sonatina" (Andre)	—	"Bagatelle" (Schumann)
"Sonatina" (Vivace) (Clementi)	—	"Carnival" (Couperin)
"Little Suite" (No. 2 - March) (Gurlitt)	—	"Dance With Me" (Volkman)
"Russian Folk Song" (Beethoven)	—	"Bagatelle" (Hummel)
"Sonatina" (Schmitt)	—	"Two Eccossaies" (No. 2) (Schubert)
"Six Miniatures" (No. 1) (Bartok)	—	"Six Miniatures" (No. 4) (Bartok)
"Seven German Dances" (No. 7) (Haydn)	—	"Seven German Dances" (No. 3) (Schubert)
"Scherzo" (Haydn)	—	"Over Hill and Dale" (Volkman)
"Three Country Dances" (No. 1) (Beethoven)	—	"Le Petit Rien" (Couperin)
"Minuet" (L. Mozart)	—	"Minuet" (Telemann)
"Tender Moments" (Gretchaninoff)	—	"Morning Prayer" (Tchaikovsky)
"Minuet" (Purcell)	—	"Air" (Purcell)
"Burleske" (L. Mozart)	—	"Andante" (W. A. Mozart)
"Musette" (A. M. Bach)	—	"Ride, Ride" (Kabalevsky)
"Oriental Dance" (Rebikoff)	—	"Three Country Dances" (No. 2) (Beethoven)
"Sarabande" (Corelli)	—	"The Enchanted Garden" (Volkman)
"Four Short Canons" (No. 4) (Kunz)	—	"Andantino" (Haydn)
"March" (A. M. Bach)	—	"Evening Song" (Turk)
"Carefree" (Turk)	—	"Playing Soldiers" (Rebikoff)
"Lullaby" (Kirnberger)	—	"Rondo" (W. A. Mozart)
"Musette" (J. S. Bach)	—	"Two Eccossaies" (No. 1) (Schubert)
"Melody" (Schumann)	—	"First Dance" (Kabalevsky)
"Song of the Hussars" (Kohler)	—	"Sonatina" (Clementi)
"Seven German Dances" (Coda) (Haydn)	—	"German Dance" (Beethoven)
"Seven German Dances" (No. 1) (Haydn)	—	"Village Waltz" (Kohler)
"Four Landlers" (No. 1) (Schubert)	—	"Four Landlers" (No. 3) (Schubert)
"The Hunters" (Turk)	—	"Trumpet Tune" (Purcell)

PRACTICE MELODIES

"Chromatic Polka" (Kohler)	—	"Four Short Canons" (No. 2) (Kunz)
"German Song" (Tchaikovsky)	—	"Old French Song" (Tchaikovsky)