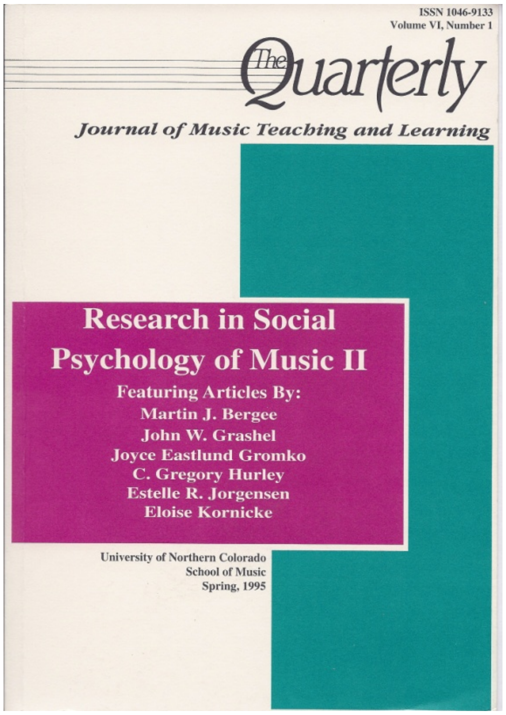

Title: Invented Iconographic and Verbal Representations of Musical Sound: Their Information Content and Usefulness in Retrieval Tasks

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Invented Iconographic and Verbal Representations of Musical Sound: Their Information Content and Usefulness in Retrieval Tasks

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Formal musical training influences an individual's iconographic representations for musical sound (Davidson & Scripp, 1989; Dowling & Harwood, 1986; Eastlund, 1992, 1993; Krumhansl & Shepard, 1979; Palmer & Krumhansl, 1990; Upitis, 1987a,b). Whereas the representations of musically untrained individuals may differ from those of musicians, musically untrained listeners are sensitive to regularities in the music they hear (Cuddy & Badertscher, 1987; Cuddy, Cohen, & Mewhort, 1981; Cuddy & Upitis, 1992; K. C. Smith, 1989; Palmer & Krumhansl, 1990; K. C. Smith & Cuddy, 1989; Upitis, 1987a). Such sensitivity has been observed in their abilities to reproduce short sound patterns and to represent them visually. Several researchers have investigated the nature of a child's mental representation for rhythm, for instance, through observation of the child's ability to actively reproduce a musical pattern and then graphically transcribe the pattern with invented notation (Bamberger, 1980, 1982; Eastlund Gromko, 1994; K. C. Smith, 1989; Upitis, 1985, 1987a).

> ...novice listeners attend to music's regularities, represent the regularities in ways that differ from experienced listeners, and invent representations that resemble the musical sound more directly than the more abstract traditional staff notation.

In an attempt to examine the relationship between iconographic representations and individuals' perceptions of sound, Walker (1981, 1983, 1985, 1987a,b) conducted a series of studies with subjects at different levels of musical development. Walker's subjects, young and old, inexperienced and experienced, sighted and blind, linked certain aural and visual patterns in ways that suggested the usefulness of iconographic representations of sound, particularly for

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young or inexperienced listeners. Walker's subjects "displayed a proclivity for a systematic matching of certain visual shapes with certain sounds," linking duration to length, frequency to height, and amplitude to size in their iconic images (Walker, 1992, p. 356).

Davidson and Scripp (1989) found that without the support of musical training, the representations of adult novices do not differ appreciably from those of the untrained eight-year old. Not until children had musical instruction did Davidson and Scripp find students capable of "a more fully dimensionalized notation which includes phrase structure, regular pulse and surface rhythm co-ordinated by metre, contour and pitches co-ordinated by a scale or key" (p. 64). According to Davidson and Scripp, the quality of adult novices' invented representations differed considerably between novices. Thus, Davidson and Scripp hypothesized that the ability to represent sound follows a developmental sequence from enactive to iconic to symbolic, reflecting the listener's understanding of music.

About the more abstract form of visual representation, that of staff notation, Walker (1981) stated: "It can be said that staff notation bears a resemblance to verbal language in its mnemonic function, and in the manner in which both bear no resemblance to the internalized image of the event they represent" (p. 111). For novices, then, staff notation represents an abstract symbolic mode more complex than their musical understanding. Researchers have not examined the extent to which iconographic representations or verbal descriptions invented by novices like themselves assist them in understanding and remembering music.

Research has established that novice listeners attend to music's regularities (Cuddy & Upitis, 1992), represent the regularities in ways that differ from experienced listeners (Davidson & Scripp, 1989), and invent representations that resemble the musical sound more directly than the more abstract traditional staff notation (Walker, 1992). Researchers have also shown that the invented representations of adult novices at early levels of understanding do not always match their remembered sound (Davidson & Scripp, 1989). While more advanced adult novices tend to depict duration, amplitude, and frequency in predictable ways, their images are idiosyncratic to their particular understanding of the music based on their training (Davidson & Scripp, 1992). In this study, I investigated the iconographic and verbal representations of adult non-musicians, defined as novice listeners, for musical sound. I sought the distinctions between invented iconographic and verbal representations of music. Novice listeners assessed the information content of invented representations and used them in immediate retrieval of musical information. I further sought the distinctions among three inventors for the information content and usefulness of their particular iconographic and verbal representations. Null hypotheses were as follows:

Part One:

1. There will be no difference between iconographic and verbal representations for their information content as perceived by other novice listeners.
2. There will be no difference among inventors for the information content of their original iconographic and verbal representations.

Part Two:

3. There will be no difference between iconographic and verbal representations for their usefulness in immediate retrieval of musical information.
4. There will be no difference among inventors for the usefulness of their original iconographic and verbal representations.

Method

Subjects

Undergraduate non-music majors (N=127), ranging in age from 17 to 30, served as subjects for this study. All subjects were elementary education majors enrolled in a required music methods course and were voluntary participants in the study. Sixty percent of the subjects had participated in some form of ensemble performance throughout high school. Thirteen percent were inactive in school music beyond grade school and 24 percent terminated school music after junior high. Three percent responded that they were currently singing with the college ensembles.

Table 1

Percentages of Representational Level by Musical Experience

Iconographic Representation	Grade School	Junior High	High School	College	Row%
	Grade Level When Musical Experience Terminated				
Low Level (1)	5%	14%	27%	2%	48%
Medium (2)	8%	9%	29%	1%	47%
High (3)	0	1%	4%	0	5%
Column %	13%	24%	60%	3%	100%

Verbal Representation	Grade School	Junior High	High School	College	Row%
Low Level (1)	11%	20%	45%	2%	78%
Medium (2)	2%	3%	9%	1%	15%
High (3)	0	1%	6%	0	7%
Column %	13%	24%	60%	3%	100%

Subjects were tested in four groups of approximately 40 listeners each. Testing took place in five sessions lasting about 30 minutes each.

Procedure

Part One

The musical stimuli used in the current study (see Appendix A) are the same as those from previous studies that examined novice and expert perceptions of stylistic similarity (Eastlund, 1992; Eastlund Gromko, 1993). During a preliminary data collection session, all novice listener subjects (N=127) were asked to "create an iconographic representation of the musical sound, using lines, shapes, or graphics" for fifteen 15-second excerpts of European art music written between 1762 and 1896 (see Appendix A). On a second hearing that followed immediately, subjects were asked to "verbally describe the musical sound, that is, use words to describe the musical events." The excerpts were presented in the same order and subjects had reference to their icons when writing their verbal descriptions. A professor and research assistant coded the pool of 127 iconographic and verbal representations according to an adaptation of the developmental levels discussed by Davidson and Scripp (1989). Extramusical scenes or cartoonlike images were coded as "1"; "enactive scribbles that captured the action of the piece" (Davidson & Scripp, 1989, p. 63) were coded as "2"; and icons showing melodic contour, rhythmic

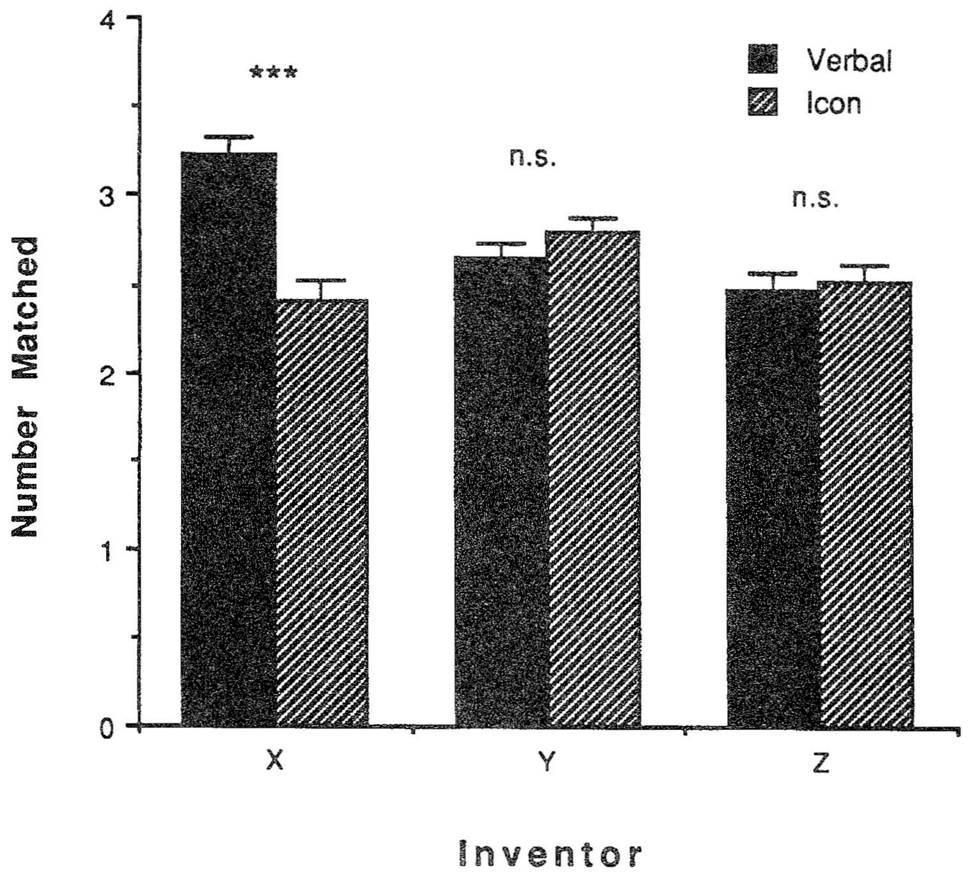


Figure 1. The number of musical excerpts matched with invented verbal and iconographic representations, shown by inventor. (Error bars represent the mean plus 1 standard error.)
***p<.001.

grouping of pitches, dynamics, or texture of the music were coded as "3." Verbal descriptions that consisted of one adjective describing a character or a mood were coded as "1"; those with words that related to one musical dimension, such as tempo or pitch, were coded as "2"; those with words that described melodic contour, rhythmic groupings of pitches, dynamics, texture, or combinations of these were coded as "3."

Descriptive statistics from the survey are shown in Table 1. Forty-eight percent of the iconographic representations were coded as "1," 47 percent as "2," and 5 percent as "3." Seventy-eight percent of the verbal representations were coded as "1," 15 percent as "2," and 7 percent as "3." The inventors were selected for comparison on the basis of having both iconographic and verbal representations coded as "3's." Of the six inventors whose representations met that criteria, only three were chosen for comparison. I selected only five items per inventor so that I could compare listeners' responses to three inventors rather than only one. I divided the 15 items among three inventors, resulting in 5 items per inventor. Their representations are shown in Appendix B.

In Part One, the second testing session, subjects were presented with a response sheet numbered from 1 to 15. Following the number that conformed to a musical excerpt were three icons - one accurate icon and two inaccurate icons. The accurate icon was the

Table 2

Repeated Measures Analysis of Variance for Sound Match to Verbal Representation by Inventor

Source	Sum of Squares	df	Mean Squares	F	p
Between-subjects					
Error	144.54	126	1.15		
Within-subjects					
Inventor	41.01	2	20.51	20.21	<.001
Error	255.65	252	1.01		

inventor's icon selected for that particular musical excerpt. The inaccurate icons were invented by one of the other six code "3" inventors for a different musical excerpt. Subjects were presented with the fifteen 15-second musical excerpts with three possible icon choices for each and instructed to "match the sound of the music with the icon that best represents the musical sound." In the third testing session, subjects were presented with a similar response sheet for verbal descriptors. The response sheet contained one accurate verbal descriptor and two inaccurate verbal descriptors, chosen at random from those invented by different inventors for different excerpts, for each of fifteen 15-second musical excerpts. Subjects were instructed to "match the musical sound with a verbal description that best represents the musical sound."

Responses were coded in the following manner. If a subject circled the accurate icon on number 1, the response was coded as "Y" for yes. If they chose an inaccurate icon, they were coded as "N" for no. An accuracy score was calculated for each subject that reflected the number of accurate iconographic representations out of 15 that he or she selected and the number of accurate verbal representations selected. The accuracy scores for all 15 excerpts were compared first. Accuracy scores for each of the three inventors were then calculated and data were analyzed with StatView (Abacus Concepts, 1992).

Results

Subjects matched the sound to its corresponding verbal description (M=8.37, SD=1.86) significantly more often than they matched the sound to its corresponding iconographic representation (M=7.73, SD=1.95), $t(125) = 2.88$, $p<.01$. Because research has shown that an inventor's representations are idiosyncratic to his/her understanding of music (Davidson & Scripp, 1989), the comparison of icons and descriptors was extended to individual inventors. Figure 1 shows the comparison of icons and descriptors for each of the three inventors. For Inventor X, subjects matched the sound to her corresponding verbal description (M=3.24, SD=1.07) significantly more often than they did to her iconographic representations (M=2.42, SD=1.14), $t(125) = 6.29$, $p<.001$. For Inventor Y, subjects did not differ in the match of sound to verbal (M=2.65, SD=.89) or iconic representations (M=2.80, SD=.99), $t(125) = -1.26$, n.s. No differences were found between verbal descriptors (M=2.48, SD=1.11) and icons (M=2.52, SD=1.10) for Inventor Z, $t(125) = -.29$, n.s.

Inventors were then compared to one another for the mean number of matches to verbal representations and then iconographic representations with a one-way repeated measures ANOVA (see Table 2). The single significance test was a within-subjects test that compared the mean accuracy scores for

Table 3

Repeated Measures Analysis of Variance for Sound Match to Iconographic Representation by Inventor

Source	Sum of Squares	df	Mean Squares	F	p
Between-subjects					
Error	158.97	126	1.26		
Within-subjects					
Inventor	9.71	2	4.85	4.36	.01
Error	280.29	252	1.11		

the three inventors (Abacus Concepts, 1992, p. 327). Results showed significant differences for verbal representations among inventors, $F(2,252) = 20.21$, $p<.001$.

A similar one-way repeated measures ANOVA was performed for icons. Significant differences were also found for iconographic representations among inventors, $F(2,252) = 4.36$, $p=.01$ (see Table 3).

On the basis of these analyses, the null hypothesis that there will be no difference between iconographic and verbal representations for the information they contain according to novice listeners was rejected. The null hypothesis that there will be no difference among inventors for the information content of their original iconographic and verbal representations was also rejected.

Part Two

In Part Two, the usefulness of iconographic and verbal representations for remembering musical sound was explored. The research suggests that invented representations may or may not be useful for remembering musical sound (Davidson & Scripp, 1992). Immediate recall tests the most fundamental of sound matches: Is this music the same as the music you just heard? The more potent the representation, presumably, the more useful. In other words, the greater the connection between sound and representation for the listener, the more useful the representation will be when the subject is faced with a task that requires immediate recall. Part Two examined whether novice-generated representations were sufficiently potent to be useful in tasks requiring immediate recall of musical information by novice listeners.

In the fourth testing session, subjects were presented with a response sheet on which all 15 accurate iconographic representations were displayed. Subjects first listened to each excerpt and looked at its corresponding accurate iconographic representation. They were instructed on this first hearing to "memorize the sound of the excerpt and its iconographic representation" because they would be tested on their ability to match the musical excerpt with its iconographic representation. On a second hearing that followed immediately, the order of excerpts were rearranged for random presentation. Subjects were told that the excerpts had been reordered and were asked to "match the musical sound with its corresponding iconographic representation."

During the fifth and final testing session, subjects were presented with a response sheet on which all accurate verbal descriptions were displayed. Subjects were instructed to "memorize the sound of the excerpt and its verbal description" because they would be tested on their ability to immediately recall the musical information. On a second hearing, the excerpts were

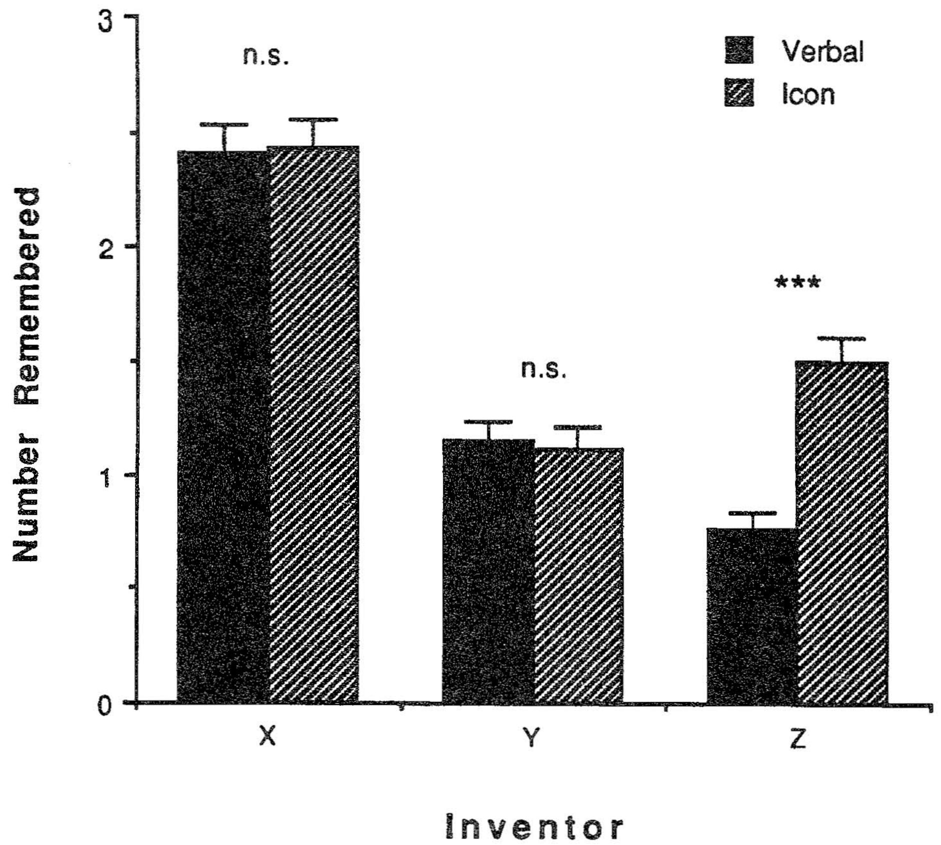


Figure 2. The number of musical excerpts remembered with invented verbal and iconographic representations, shown by inventor. (Error bars represent the mean plus 1 standard error.)
***$p<.001$.

reordered and subjects were asked to "match the musical sound with its corresponding verbal description."

As in Part One, responses were coded as "Y" for accurate and "N" for inaccurate. An accuracy score was calculated for each subject that reflected both the number of iconographic representations out of 15 that he or she matched to their corresponding musical sound and the number of accurate verbal representations that were matched. The accuracy scores for icons and verbals for all 15 excerpts were compared first. Accuracy scores for each of the three inventors were then calculated and compared.

Results

Subjects matched the sound to its corresponding verbal description (M=4.33, SD=2.21) significantly less often than they matched the sound to its corresponding iconographic representation (M=5.05, SD=2.74) on this memory task, $t(125) = -2.70$, $p<.01$. The expected number of accurate responses was determined by simulation on a Macintosh IIci computer with Think Pascal (Symantec, 1991). In the simulation, responses were assigned by random number, simulating guessing behavior. The mean number of accurate responses in 100,000 computer trials was 1.

Table 4

Repeated Measures Analysis of Variance for Sound Memory of Verbal Representation by Inventor

Source	Sum of Squares	df	Mean Squares	F	p
Between-subjects					
Error	204.70	126	1.63		
Within-subjects					
Inventor	186.79	2	93.40	101.21	<.001
Error	232.54	252	.92		

Because research has shown that an inventor's representations are idiosyncratic and may or may not be useful to others, the comparison of icons and descriptors was extended to an examination of the usefulness of representations of individual inventors. Figure 2 shows the comparison of icons and descriptors for each of the three inventors. No differences were found between verbal descriptors (M=2.41, SD=1.34) and icons (M=2.43, SD=1.43) for Inventor X, $t(125)$ = -.16, n.s. For Inventor Y, subjects did not differ in the match of sound to verbal descriptors (M=1.15, SD=1.02) or iconic (M=1.11, SD=1.08) representations, $t(125)$ = .32, n.s. For Inventor Z, subjects matched the sound to his corresponding iconographic representations (M=1.50, SD=1.19) significantly more often than they did to his verbal representations (M=.77, SD=.79), $t(125)$ = -6.26, p<.001.

Inventors were then compared to one another for the mean number of matches to verbal representations with a one-way repeated measures ANOVA (see Table 4). The single significance test was a within-subjects test that compared the mean accuracy scores for the three inventors (Abacus Concepts, 1992, p. 327). Results showed significant differences for verbal representations among inventors, $F(2,252)$ = 101.21, p<.001: Inventor X (M=2.41, SD=1.34), Inventor Y (M=1.15, SD=1.02), and Inventor Z (M=.77, SD=.79).

A similar one-way repeated measures ANOVA was performed for icons. Significant differences were also found for iconographic representations among inventors, $F(2,252)$ = 55.20, p<.001 (see Table 5): Inventor X (M=2.43, SD=1.43), Inventor Y (M=1.11, SD=1.08), and Inventor Z (M=1.50, SD=1.19).

On the basis of these analyses, the null hypothesis that there will be no difference between iconographic and verbal representations for their usefulness in immediate retrieval of musical information was rejected. The null hypothesis that there will be no difference among inventors for the usefulness of their original iconographic and verbal representations was also rejected.

Discussion

The purpose of this study was to examine novice-generated iconographic and verbal representations of musical excerpts: their information content, and their usefulness in a task of immediate recall. If the novice-generated representation reflects the novice's musical understanding and attention to music's regularities (Davidson & Scripp, 1989; Cuddy & Upitis, 1992), then these results suggest that the subject sample displayed early levels of understanding (see Table 1). Fewer than one-half of the novice listeners (N=127) indicated perception of musical regularities on

Table 5

Repeated Measures Analysis of Variance for Sound Memory of Iconographic Representation by Inventor

Source	Sum of Squares	df	Mean Squares	F	p
Between-subjects					
Error	315.91	126	2.51		
Within-subjects					
Inventor	117.19	2	58.59	55.20	<.001
Error	267.48	252	1.06		

the basis of their iconic representations and fewer than one-fourth in their verbal descriptions. In the preliminary stages of the project, 48 percent of the novice subjects generated icons that depicted extramusical scenes or cartoonlike figures, and 78 percent described the music with adjectives such as "a bad guy," "a scary scene," "Bugs Bunny," or "the grim reaper." For those novices who did generate iconic representations related to musical dimensions, fewer than one-eighth of them (5 percent of the total sample) invented representations that included more than enactive scribbles related to the rhythmic dimension. The shapes within these iconographic representations resembled those found by Walker (1992), in which duration was linked to length, pitch was reflected in images placed high or low in paper-space, and amplitude was shown by size of visual image. With 60 percent of these subjects claiming participation in some form of musical performance throughout high school, the quality of their representation reflects early levels of understanding of music despite their musical performance activity.

The results suggest that the amount of information received by subjects differed for novice-invented iconographic and verbal representations. In Part One, subjects received more information from verbal descriptions than iconographic representations. Further analyses showed that those differences were due mainly to Inventor X, whose verbal descriptions were significantly more informative than were her iconographic representations.

The usefulness of icons and descriptors as aids to immediate retrieval of musical information differed. In Part Two, subjects found iconographic representations to be more useful than verbal descriptions in a task that required immediate recall of musical information. Further analyses showed that these differences were due to Inventor Z's iconographic descriptions, that were significantly more useful than were his verbal descriptions. As for the relationship between representations and remembered sound, the overall performance on the memory task in Part Two indicates that immediate recall of musical sound was difficult for the novices, and that few of the selected representations were sufficiently potent to be useful for the novice listeners.

Overall, the poor performance by subjects on the tasks parallels their lack of musical listening training. Thus, this study lends limited evidence to the theory that invented representations reflect musical understandings and that early levels of musical understanding may, in turn, limit the usefulness of representations as aids to memory.

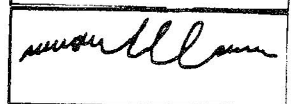
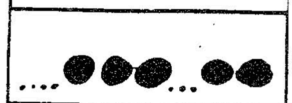
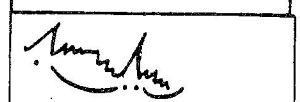
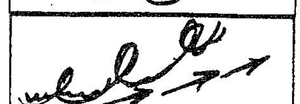
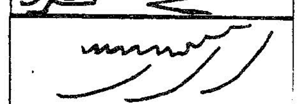
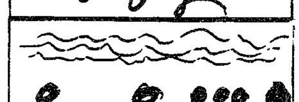
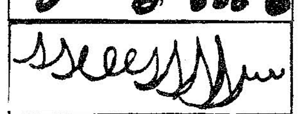
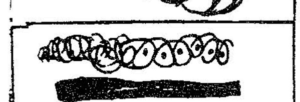
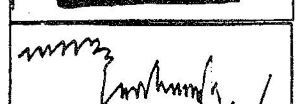
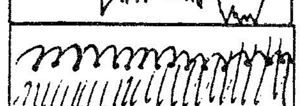
Appendix A

Stimulus Materials

Composer	Composition Title	Date	Compact Disc Start Point
L. Mozart	*Concerto for Trumpet in D* Allegro Moderato	1762	EMI CDC 7 49237 at :08 measures 2-16
J.C. Bach	*Sinfonie in gm* Allegro di molto	1770	Jecklin J 4408-2 at :07 measures 4-12
J.B. Vanhal	*Sinfonie in gm* Finale: Allegro	1770	Jecklin J 4408-2 at :37 measures 24-34
C.P.E. Bach	*Sinfonie in F* (Index 665) Presto	1775-6	Capriccio 10 999 at :19 measures 24-43
F.J. Haydn	*Symphony No. 87 in A* Vivace	1785	Laser Light 15 830 at :54 measures 37-47
W.A. Mozart	*Symphony No. 41 in C* K 550, Allegro vivace	1788	Laser Light 15 829 at 2:14 measures 275-287
LVanBeethoven	*Symphony No. 3 in E-flat* Opus 55, Scherzo	1803	L'Oiseau-Lyre (Decca) at :50 measures 92-115
L. Cherubini	*Symphony in D* Allegro Assai	1815	Divox 011-042 at 1:34
F. Schubert	*Symphony No. 3 in D* D 200, Presto vivace	1815	LaserLight 15 823 at :35 measures 55-78
F. Mendelssohn	*Symphony No. 3 in am* Opus 56, vivace non troppo	1842	LaserLight 15 822 at 1:44 measures 115-124
R. Schumann	*Symphony No. 2 in C* Opus 61, Scherzo	1845-6	LaserLight 15 827 at :36 measures 31-47
G. Bizet	*L'Arlesienne Suite No. 1* Carillon	1872	LaserLight 15 614 at :06 measures 5-16
J. Brahms	*Symphony No. 4 in em* Opus 98, Allegro giocoso	1884-5	Harmonia Mundi (Angel) CDC-7 47589 at 2:05 measures 125-141
A. Dvorak	*Symphony No. 9 in em* Scherzo	1893	LaserLight 15 824 at 1:12 measures 39-58
R. Strauss	*Also Sprach Zarathustra* Das Tanzlied	1895-6	DG 410 959-2 at 2:28 rehearsal numbers 31-32

Appendix B

Invented Iconographic and Verbal Representations

Piece	Iconographic Representation	Verbal Representation
Inventor X L. Mozart Concerto for Trumpet in D		horns dancing tiny sounds
Vanhal Sinfonie in gm		rush fast slow, slow, slow quick, quick
C. P. E. Bach Sinfonie in F		tiny steps big loud tiny steps
Bizet L'Arlesienne Suite No. 1		horns sounding, music flowing out off/on
R. Strauss Also Sprach Zarathustra		dancing, swinging, twirling, smooth, graceful
Inventor Y F. J. Haydn Symphony No. 87 in A		snowball with whole note underline
Mendelssohn Symphony No. 3 in am		running upward spiral
Schumann Symphony No. 2 in C		chasing, escalating dramatic breaks in motion
Brahms Symphony No. 4 in em		downward snowball slows and smooths
Dvorak Symphony No. 9 in em		smooth, downward spiral chopping quick underline
Inventor Z J. C. Bach Sinfonie in gm		joyful on top with deep underbeats
W. A. Mozart Symphony No. 41 in C		builds up big, then gets small again
Beethoven Symphony No. 3 in E-flat		strong continuous underpart
Cherubini Symphony in D		goes along, then drops, goes further then drops again
Schubert Symphony No. 3 in D		continuing on top, but overshadowed from the bottom

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