Journal of Experimental Psychology:
Learning, Memory, and Cognition
2004, Vol. 30, No. 2, 370–381

0278-7393/04/$12.00 DOI: 10.1037/0278-7393.30.2.370

Liking and Memory for Musical Stimuli as a Function of Exposure

Karl K. Szpunar, E. Glenn Schellenberg, and Patricia Pliner
University of Toronto

Three experiments examined changes in liking and memory for music as a function of number of previous exposures, the ecological validity of the music, and whether the exposure phase required focused or incidental listening. After incidental listening, liking ratings were higher for music heard more often in the exposure phase and this association was stronger as ecological validity increased. After focused listening, liking ratings followed an inverted U-shaped function of exposure for the most ecologically valid stimuli (initial increases followed by decreases), but this curvilinear function was attenuated or nonexistent for less valid stimuli. In general, recognition improved as a function of previous exposure for focused listeners, but the effect was attenuated or absent for incidental listeners.

Since Zajonc's (1968) report that "mere exposure is a sufficient condition for attitude enhancement" (p. 15), there have been numerous replications and extensions of the finding that simple exposure to a novel, neutral stimulus increases liking for it (for a review, see Bornstein, 1989). On the basis of a meta-analysis of the relevant literature, Bornstein concluded that the effect is stronger (a) for complex than for simple stimuli, (b) for exposure to multiple stimuli than for a single stimulus presented repeatedly, (c) for brief stimuli (e.g., 1 s or less for visual stimuli) with relatively few repetitions, and (d) when a delay intervenes between exposure and ratings of liking.

One puzzling and provocative aspect of the *mere exposure effect* is the occurrence of increases in liking even in the absence of stimulus recognition (e.g., Zajonc, 1980). In fact, the effect is stronger under subliminal than supraliminal conditions (Murphy, Monahan, & Zajonc, 1995) and when participants have no explicit memory for the stimuli (Bornstein, 1989; Bornstein & D'Agostino, 1992). In one study (Kunst-Wilson & Zajonc, 1980), participants were exposed to five 1-ms exposures of each of several polygons. They subsequently saw pairs of polygons, one of which had been presented previously. Their tasks were to select the preferred polygon in each pair and to select the one that seemed more familiar. Although previously exposed polygons were preferred more often than chance (60%), recognition was at chance levels (48%). The influence of exposure on preference in the absence of explicit memory has been documented repeatedly in the visual domain (Barchas & Perlaki, 1986; Bonanno & Stillings, 1986; Bornstein, Leone, & Galley, 1987; Mandler, Nakamura, & Van Zandt, 1987; Seamon, Brody, & Kauff, 1983; Seamon, Marsh, & Brody, 1984) and in the auditory domain (Peretz, Gaudreau, & Bonnel, 1998; Wilson, 1979). On the basis of these findings, Zajonc (2001) argued that exposure effects can occur without previous cognitive appraisal, or that "preferences need no inferences" (Zajonc, 1980, p. 151).

Zajonc (2001) attributed the association between exposure and preference to *conditioning*, specifically to the absence of adverse consequences after exposure to the target stimulus. He and his associates argued, moreover, that exposure effects are diffuse, leading to enhanced affect for stimuli other than those exposed previously (Monahan, Murphy, & Zajonc, 2000; Murphy et al., 1995) and to mood elevation in those who experience repeated exposures (Monahan et al., 2000). Nonetheless, their perspective was limited to stimuli presented subliminally. It is therefore of limited relevance to the vast majority of stimuli encountered in daily life or in the laboratory.

Two theories provide accounts of mere exposure effects that extend to supraliminal stimuli. One, the *perceptual fluency/attributional model* (Bornstein, 1992; Bornstein & D'Agostino, 1994), emphasizes different cognitive ramifications of recognized and unrecognized stimuli. Previous exposure is thought to activate context-free representations of stimuli, resulting in *perceptual fluency* (Jacoby, 1983; Jacoby & Kelly, 1987; Jacoby & Whitehouse, 1989), which refers to rapid and efficient processing of previously encountered stimuli. Depending on the available contextual cues, participants may misattribute perceptual fluency to properties of the stimulus instead of to previous exposure (Jacoby & Whitehouse, 1989; Mandler et al., 1987). For example, if exposure is followed by evaluative questions about an unrecognized stimulus, participants interpret their apparent ease of processing as a positive disposition toward the stimulus (Bornstein, 1992). Similarly, questions about stimulus brightness and darkness result in enhanced judgments of brightness and darkness, respectively (Mandler et al., 1987). According to Bornstein (1992; Bornstein & D'Agostino, 1994), repeated supraliminal presentation generates increased awareness of the stimulus, which leads participants to "correct" or reinterpret fluency-based affective responses. Essentially, participants' explicit memory enables them to interpret the perceptual fluency they experience in terms of exposure rather

Karl K. Szpunar, E. Glenn Schellenberg, and Patricia Pliner, Department of Psychology, University of Toronto, Mississauga, Ontario, Canada.

Karl K. Szpunar is now at the Department of Psychology, Washington University in St. Louis.

This research was supported by the Natural Sciences and Engineering Research Council of Canada. We thank Sandra Trehub and Frank Russo for their helpful comments on earlier versions of this article.

Correspondence concerning this article should be addressed to E. Glenn Schellenberg, Department of Psychology, University of Toronto at Mississauga, Mississauga, Ontario L5L 1C6, Canada. E-mail: g.schellenberg@utoronto.ca

than affect. The presumption is that *increases* in recognition accuracy will be accompanied by *decreases* in positive affect toward a stimulus.

An alternative account of associations between liking and exposure is provided by the *two-factor model* proposed by Berlyne (1970) and Stang (1974). Evaluations of supraliminally presented stimuli are said to form an inverted U-shaped function of arousal potential. Stimuli with little arousal potential—those that are too familiar or too simple—receive relatively low evaluations, as do stimuli with too much arousal potential, those that are too unfamiliar or too complex. Rather, stimuli with intermediate levels of arousal potential are evaluated most favorably. The model includes two opposing processes. One involves the dissipation of neophobia or the development of "learned safety" (Kalat & Rozin, 1973), which generates enhanced affect as a stimulus becomes more familiar and less threatening through benign contact. This component is consistent with Zajonc's (2001) account. The second process is boredom, which increases with increasing exposure. Presumably, exposure generates increases in positive affect until boredom outweighs the benefits of learned safety, resulting in *satiation,* or decreases in liking.

Although stimulus-enhancement effects after repeated exposure are highly reliable, satiation effects are elusive. In some cases, satiation occurs after relatively few exposures (e.g., Bornstein, Kale, & Cornell, 1990; Kail & Freeman, 1973; Stang & O'Connell, 1974). In others, no satiation is apparent after 80 or more exposures (Zajonc, Crandall, Kail, & Swap, 1974; Zajonc, Swap, Harrison, & Roberts, 1971). In a particularly good example of the ephemeral nature of satiation effects, Zajonc, Shaver, Tavris, and van Kreveld (1972) found that liking ratings for reproductions of artworks increased from zero to five exposures but decreased steadily with further exposure. When the experiment was repeated with photographs of men and nonsense syllables, stimulus evaluation increased as a function of exposure, but there was no evidence of satiation.

Anecdotal observations are suggestive of striking enhancement and satiation effects involving music. For example, radio and TV exposure of popular recordings has well-documented effects on consumer purchases of such recordings, not to mention widespread singing of these songs in the shower and elsewhere. For a time, consumers clamor for repeated airing of these recordings, followed by increasing dislike of the songs heard most frequently (Jakobovits, 1966). A more dramatic pattern of preferences sometimes emerges in individuals who normally avoid orchestral music. These individuals can become devotees of specific pieces (e.g., *Bolero* by Ravel, *Canon in D Major* by Pachelbel, or *Also Sprach Zarathustra* by Strauss) after the music has been used for dramatic effect in popular films (e.g., *10, Ordinary People,* or *2001: A Space Odyssey*). Although it is impossible to make unequivocal attributions of such liking to simple exposure rather than to specific, positive associations, these observations encouraged us to examine relations among exposure, liking, and memory for music.

In the last 100 years, there have been approximately 20 published studies concerned with the affective consequences of exposure to music. In most cases, there were small to moderate numbers of presentations, which resulted in the usual increases in liking (Brickman & D'Amato, 1975; Heingartner & Hall, 1974; Krugman, 1943; Meyer, 1903; Mull, 1957; Obermiller, 1985; Peretz, Gaudreau, & Bonnel, 1998; Wilson, 1979). In some cases, increases in affect varied as a function of the type of music presented (Bartlett, 1973; Bradley, 1971; Downey & Knapp, 1927; Gilliland & Moore, 1927; Washburn, Child, & Abel, 1927). Suggestive evidence of satiation was apparent in some studies (Bartlett, 1973; Brentar, Neuendorf, & Armstrong, 1994; Hargreaves, 1984; Heyduk, 1975; Verveer, Barry, & Bousfield, 1933), but none of these studies examined possible links between evaluations and memory. The absence of satiation in most studies may result from insufficient exposure. Specifically, the characteristic focus on *increases* in liking as a function of exposure may have led to a limited number of exposures because increases often plateau after about 10 exposures (Bornstein, 1989). Indeed, one of the two studies that involved the use of more than 20 presentations revealed a small decline in liking after 16 presentations (Brentar et al., 1994).

The principal goal of the present investigation was to examine liking for music as a function of previous exposure. A second goal was to identify how liking and explicit memory covary as a function of exposure in different contexts. Accordingly, participants rated how much they liked each stimulus *and* how well they remembered it. In each of the three experiments, we attempted to maximize the likelihood of recognition among some listeners by requiring them to focus on the music during the exposure phase. We reduced the likelihood of recognition among other listeners by having them hear the same stimuli incidentally while they focused on a distractor task. The vast majority of musical experiences involve incidental listening, with focused music listening (e.g., at concerts) being an important but much less common activity (Sloboda, O'Neill, & Ivaldi, 2001).

In all three experiments, we included a wide range of exposure frequencies that were conducive to liking and to satiation so that we could evaluate whether moderate numbers of presentations would produce the usual increase in liking and whether large numbers would produce a decrease in liking. The experiments differed in the kinds of musical stimuli and the tasks used in the focused-listening conditions. This variation was motivated by Bornstein's (1989) conclusion that exposure effects depend on stimulus complexity. We assumed that, in the musical domain, stimulus complexity was roughly equivalent to ecological validity and that the most ecologically valid experiences involved listening to recordings of real music in a musically relevant manner. Thus, the three experiments differed in the extent to which the exposure phase was experienced as involving real music. Experiment 1 provided the least musical experience, Experiment 2 provided the most, and Experiment 3 fell between the two. Accordingly, if ecological validity affects liking, the results of Experiment 3 should be intermediate between those of Experiments 1 and 2.

Experiment 1

We evaluated listeners' liking and memory for tone sequences presented at different exposure frequencies. The stimuli were monophonic (one tone at a time) sequences of five to nine piano tones that did not conform to any Western major or minor scale. They consisted of tones of equal amplitude and duration, such that the sequences sounded unfamiliar, mechanical, and relatively nonmusical. These relatively impoverished stimuli could be described in terms of a few parameters (number of tones, specific pitches, and pitch contour). The sequences were not ecologically valid, but they were similar to those used previously (Wilson, 1979). Moreover, although simplicity (or complexity) is difficult to quantify, our tone sequences were analogous in some respects to the controlled visual stimuli (i.e., polygons, line drawings, and Chinese ideographs) used in many studies (Bornstein & D'Agostino, 1992, 1994; Bornstein et al., 1987, 1990; Kunst-Wilson & Zajonc, 1980; Mandler et al., 1987; Monahan et al., 2000; Seamon et al., 1983, 1984, 1995; Whittlesea & Price, 2001), which can also be described with a few parameters. The orienting task that required listeners in the focused condition to attend closely to the stimuli was also nonmusical. These listeners were required to count the total number of tones in each sequence.

We expected that repeated exposure would improve recognition and that this association would be a more robust consequence of focused than incidental listening. We also expected exposure-dependent increases in liking to be greater with incidental listening because of limited memory for the stimuli (Bornstein, 1989). Because focused listening accelerates the familiarization process, it was expected to promote boredom resulting from excessive familiarity, with the nonmusical orienting task exaggerating this process.

Method

Participants. The listeners were 50 undergraduates who received partial course credit or token remuneration for participating in the study.

Apparatus and stimuli. Testing took place in a sound-attenuating booth. The stimuli were presented over headphones (Sony MDR-CD370) at a comfortable listening level. The stimuli were 30 sequences of 5 to 9 piano tones from Thompson, Balkwill, and Vernescu (2000). Their research was not designed to test effects of exposure on preference and memory, but a subsidiary finding was higher ratings for previously exposed sequences than for novel sequences, even when the former sequences were not recognized. We modified several sequences (Thompson et al., 2000, Appendix) so that we had an equal number (i.e., 6) of each of five lengths (5, 6, 7, 8, or 9 tones). For example, a sequence of 6 tones—1, 2, 3, 4, 5, 6—was extended to 9 tones by adding Tones 5, 4, and 3 to the end. Examples of the tone sequences are provided in Figure 1 with musical notation.

Musical Instrument Digital Interface (MIDI) files were created for each sequence with sequencing software (Cubase 2.8), ensuring that each tone had identical duration and amplitude. Interonset intervals between tones within sequences were 300 ms. The files were routed to a MIDI interface (Mark of the Unicorn) and a Roland JV-90 synthesizer (piano timbre) and then rerecorded as digital sound files (CD quality, i.e., 16 bit, sampling rate of 44.1 kHz) with SoundEdit 16 (Version 2) software. Stimulus presentation and response recording were controlled by a customized program created with PsyScope 1.1 software (Cohen, MacWhinney, Flatt, & Provost, 1993). The distracting stimulus was an excerpt from a narrated story written by Stephen King called *The Green Mile* (King, 1996). The text was rerecorded from an audiocassette and stored as a digital sound file.

Procedure. Thirty participants were assigned to focused listening and 20 to incidental listening. We included additional participants for focused listening to ensure that null effects on liking ratings did not result from a lack of power. The procedure consisted of three phases that occurred in immediate succession: (a) exposure, (b) liking ratings, and (c) recognition ratings. Only the exposure phase differed across conditions.

Participants were informed that the procedure had three phases. For each participant in focused listening, 18 target stimuli were selected randomly from the set of 30. Participants heard 6 of the 18 stimuli in the exposure phase, 2 of which were presented 4 times, 16 times, or 64 times, for a total of 168 presentations. Randomization was constrained so that the same excerpt could not occur on consecutive trials. Participants' task was to count the number of tones in each sequence and select one of the response

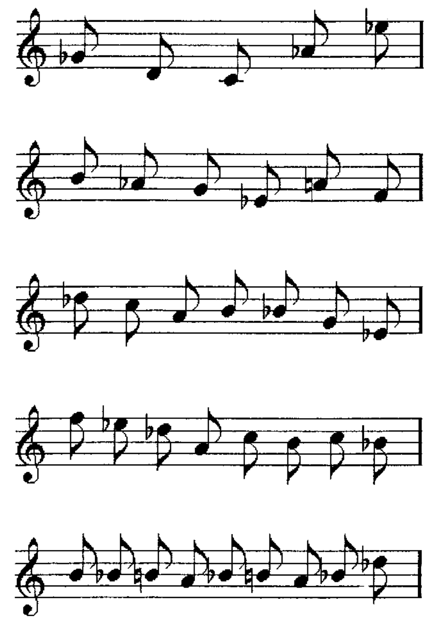

Figure 1. Examples of tone sequences used in Experiment 1. There were six different sequences for each different length (5, 6, 7, 8, or 9 tones).

options of 4 to 10. They were told that some sequences would differ very subtly from others and that we were interested in the effects of this manipulation on response accuracy and speed. In fact, the task was designed simply to ensure that they listened closely to each presentation. Trials were self-paced; participants indicated their readiness for the next trial by pressing the space bar.

Each participant in incidental listening heard one of five different strings of 168 sequences ordered randomly. Each string contained six different sequences, with randomization of repetitions identical to focused listening. As a means of minimizing variation among participants in the duration of the test session, the randomization was constrained so that the sequences presented 64 times had 6 and 7 tones, those presented 16 times had 5 and 9 tones, and those presented 4 times had 8 tones. Consecutive sequences were separated by 300 ms of silence (corresponding to the duration of one tone). The distracting stimulus (the excerpt from a narrated story) matched the overall duration of the stimulus strings. Participants were instructed that they would hear two stimuli at once. In their right ear, they heard the narrated story, its maximum amplitude equaling that of sequences in focused listening (i.e., the peak amplitude was 80% of maximum before distortion). In their left ear, they heard the musical excerpts presented at reduced amplitude (30% of maximum). Participants were told to focus their attention on the story and to try to ignore the distracting stimulus in their left ear. Their task was to press one button on a button box when they heard the narrator say the word *the* and another button when they heard the word *and.* Participants were also instructed to count and remember how often they heard the word *but.* They were warned of a forthcoming memory test on the content of the story, but there was no such test. Rather, the instructions and distractor task were designed to focus listeners' attention *away* from the music. Participants heard one of the five strings of tone sequences in their unattended (left) ear. This type of incidental exposure is similar to when one is engaged in conversation but nonetheless aware of music playing in the background (e.g., at a party).

In the second phase of the experiment, participants rated how much they liked 12 of the 18 sequences using a 7-point scale (1 = *dislike extremely,* 7 = *like extremely*). The set included the 6 sequences heard in the exposure phase along with 6 additional sequences selected randomly from the 12 unheard sequences (to provide a baseline measure of liking). The 12 stimuli were presented in a different random order for each participant.

In the third phase, participants rated how confident they were that each of the 18 target sequences had been presented in the exposure phase. Ratings were again made on a 7-point scale (1 = *extremely sure not presented*, 7 = *extremely sure presented*). The excerpts included the 6 sequences from the exposure phase, the 6 sequences that were added to the second (liking ratings) phase, and an additional 6 sequences that had never been heard before (as a baseline measure of memory). The order of the 18 sequences was randomized separately for each participant. The entire procedure lasted approximately 20 min for participants in focused listening and approximately 10 min for participants in incidental listening. The difference in duration between the two conditions resulted from the fact that participants in the focused group were required to make a response after hearing each sequence and those in the incidental group were not.

Results and Discussion

Liking. For each listener, we calculated average liking ratings for excerpts heard 64 times, 16 times, and 4 times during the exposure phase (two excerpts in each case). We also calculated an average liking rating for the six excerpts heard for the first time in Phase 2, which served as a baseline measure of liking. Means are illustrated in Figure 2. We used trend analysis to examine changes in liking ratings as a function of exposure. Effect sizes are reported

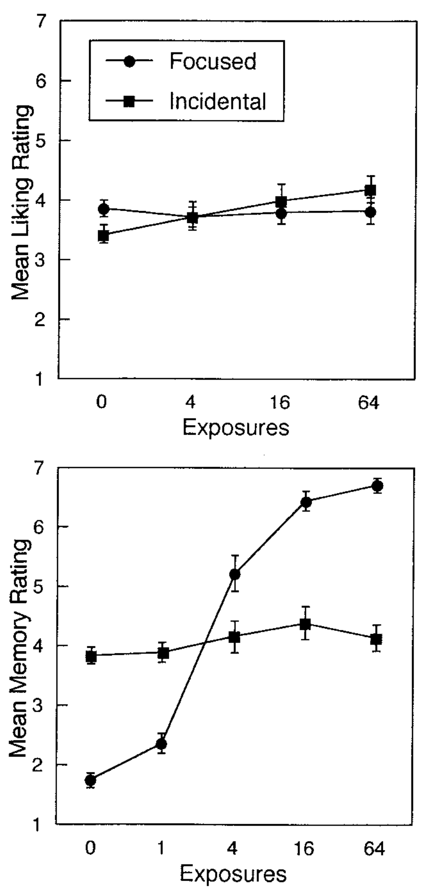

Figure 2. Mean liking and memory ratings in Experiment 1 as a function of exposure frequency and listening condition. Error bars represent standard errors.

Table 1
Effect Sizes (η^2) for Linear and Quadratic Trends in Liking and Memory Ratings as a Function of Exposure

	Focused listening		Incidental listening	
Experiment	Linear	Quadratic	Linear	Quadratic
		Liking ratings		
1	<.001	.013	*.421*	.021
2	.002	*.467*	*.632*	.001
3	.001	*.206*	*.527*	.003
		Memory ratings		
1	*.952*	*.269*	.105	.038
2	*.934*	*.209*	*.414*	.070
3	*.932*	*.433*	*.345*	.048

Note. Significant effects are italicized.

in Table 1. We observed a near-significant interaction between listening condition and a linear trend in ratings, $F(1, 48) = 3.63$, $p = .063$, but no interaction between condition and a quadratic trend.

In the case of focused listening, both linear and quadratic trends were nonsignificant. In fact, mean liking ratings varied minimally, from a low of 3.72 (four exposures) to a high of 3.85 (baseline). No pair of means differed significantly.

For incidental listening, the linear trend in liking ratings was reliable, $F(1, 19) = 13.81$, $p = .001$, but the quadratic trend was not. Comparisons of adjacent means revealed no reliable differences. Nonetheless, liking ratings were significantly above baseline levels for sequences heard 16 and 64 times, $t(19) = 2.56$, $p = .019$, and $t(19) = 4.20$, $p < .001$, respectively (see Figure 2). In addition, liking ratings increased reliably from 4 to 64 exposures, $t(19) = 2.35$, $p = .030$. Thus, incidental listening led to small but significant increases in liking as a function of exposure to these impoverished stimuli, but focused listening did not.

Memory. For each listener, we calculated average memory ratings for sequences presented 4 times, 16 times, and 64 times. We also calculated average ratings for the six sequences heard once in the second (liking ratings) phase and the six sequences heard for the first time in the third phase (baseline measure). Mean ratings are illustrated in Figure 2.

Trend analysis revealed a robust interaction between listening condition and linear increases in recognition as a function of exposure, $F(1, 48) = 261.37$, $p < .001$. There was no interaction between condition and a quadratic trend. Effect sizes for linear and quadratic trends are provided in Table 1 separately for focused and incidental listening.

For focused listening, the linear trend in recognition confidence was dramatic, $F(1, 29) = 574.47$, $p < .001$, as shown in Figure 2 and Table 1. On a 7-point scale, memory ratings varied from a low of 1.72 (baseline) to a high of 6.70 (64 exposures). Each pair of adjacent means differed significantly. Specifically, recognition confidence was higher for sequences heard once in the second phase than for baseline stimuli, $t(29) = 4.38$, $p < .001$. In other words, the former sequences were falsely recognized as occurring in the exposure phase. Recognition confidence was also higher for sequences heard 4 times than for those heard once, $t(29) = 8.24$, $p < .001$; for those with 16 relative to 4 exposures, $t(29) = 4.02$, $p < .001$; and for those with 64 relative to 16 exposures, $t(29) =$

2.33, $p = .027$. The quadratic trend was significant as well, $F(1, 29) = 10.65$, $p = .003$, because memory ratings reached near-ceiling levels after 16 exposures ($M = 6.43$).

For incidental listening, there was no linear or quadratic trend in recognition confidence. Memory ratings varied minimally, from a low of 3.83 (baseline) to a high of 4.38 (16 exposures). No pair of means differed reliably. In fact, the largest difference between means approached conventional levels of significance, $t(19) = 1.90$, $p = .073$. Thus, these listeners had virtually no explicit memory for the sequences presented in the exposure phase.

Summary. Supraliminal presentation of these tone sequences yielded findings consistent with Bornstein's (1989) conclusion that the mere exposure effect is stronger in the absence of explicit memory. Our data provided no evidence of satiation, but they revealed completely different patterns of exposure effects for liking and explicit memory in the two listening contexts. When listeners' attention was focused on our impoverished stimuli, repeated presentation resulted in improved recognition but did not affect listeners' evaluation of the stimuli. By contrast, incidental listening to the same stimuli produced reliable increases in liking as a function of exposure but no explicit memory for the stimuli. These data are consistent with the perceptual fluency/attributional account of mere exposure effects, in which recognized and unrecognized stimuli have different attributional outcomes with correspondingly different affective responses.

Experiment 2

In Experiment 2, our stimuli were 15-s excerpts from commercial recordings of orchestral music. Thus, the stimuli were more complex than those of Experiment 1. Each excerpt contained multiple instruments playing different parts, and some of the instruments (e.g., keyboard instruments) played multiple tones. Excerpts were selected from pieces that were harmonically and rhythmically well defined (i.e., with a clear key and meter) with expressive timing and phrasing. A major advantage of these stimuli was their ecological validity, but a disadvantage was the multiple dimensions of difference among excerpts (e.g., orchestration, tempo, and pitch range). Nevertheless, stimulus randomization eliminated potential threats to internal validity. In addition, the task for focused listeners was a musical one that required identification of the lead instrument (i.e., the one playing the melody) in pieces that had several instruments playing simultaneously. In short, the stimuli and orienting task were ecologically valid in Experiment 2 but not in Experiment 1.

In line with Bornstein (1989), we predicted that exposure effects on liking (both increases and decreases) would be stronger for these rich, complex stimuli than for the impoverished stimuli in Experiment 1. In particular, we expected focused listening to enhance memory for the stimuli and to increase the likelihood of satiation.

Method

Participants. The participants were 40 undergraduates who were recruited as in Experiment 1.

Apparatus and stimuli. The apparatus was the same as that of Experiment 1. The stimuli were 18 excerpts of 15 s each taken from recordings available on compact disk (Table 2), 6 each from pieces written in Baroque, Classical, or Romantic/Late-Romantic styles. For the most part, we selected concerti to permit the isolation of portions featuring a lead instrument. Each excerpt had one of six different lead instruments. There were equal numbers of each lead instrument (i.e., three), but style and lead instrument were partly confounded because musical period and instrumentation are not independent. All excerpts were rerecorded from compact disks onto the computer, saved as digital sound files (CD quality), and normalized to hold peak amplitude constant across excerpts. The distracting stimulus was the same as in Experiment 1.

Table 2
Pieces From Which Stimuli Were Excerpted in Experiment 2

Style and composer	Composition	Lead instrument
Baroque		
Bach	Brandenburg Concerto No. 1 in F	Horn
Bach	Concerto in A for Oboe	Oboe
Bach	Flute Concerto in E Minor	Flute
Handel	Oboe Concerto No. 1 in B Flat	Oboe
Vivaldi	Cello Concerto in G Major	Cello
Vivaldi	Oboe Concerto in C Major	Oboe
Classical		
Beethoven	Piano Concerto No. 1 in C Major, Op. 15	Piano
Beethoven	Violin Concerto in D, Op. 61	Violin
Haydn	Cello Concerto No. 1 in C	Cello
Haydn	Cello Concerto No. 2 in D	Cello
Mozart	Horn Concerto No. 1 in D, K. 412	Horn
Mozart	Horn Concerto No. 3 in E Flat, K. 447	Horn
Romantic/Late Romantic		
Fauré	En Priere for Flute and Orchestra	Flute
Fauré	Pavane for Flute and Orchestra	Flute
Schubert	String Quartet No. 10 in E Flat Major, D87	Violin
Schubert	String Quartet No. 13 in A Minor, D804	Violin
Tchaikovsky	Piano Concerto No. 2 in D Minor, Op. 23	Piano
Tchaikovsky	Piano Concerto No. 3 in E Flat, Op. 75	Piano

Procedure. Half of the participants were assigned to focused listening and half to incidental listening. The procedure was identical to that of Experiment 1 with the following exceptions.

Focused listeners heard 84 excerpts of 15 s each of classical music during the exposure phase. Specifically, they heard 6 different excerpts selected randomly from the set of 18 (constrained such that each of the six lead instruments was featured in one excerpt), 2 of which were presented twice, 8 times, or 32 times. The orienting task was to identify the lead instrument in each excerpt. Participants were first familiarized with each of the six target instruments (cello, flute, horn, oboe, piano, and violin). The purpose of the task was to ensure that participants listened closely on each trial.

Incidental listeners also heard 84 excerpts in the exposure phase, with 6 excerpts presented multiple times (2, 8, or 32 times), as for focused listeners. The excerpts were presented consecutively, separated by 500 ms of silence. There were five different orders of the 84 excerpts, with each order randomized and constrained as for focused listeners. Participants heard one of the five strings of musical excerpts at reduced amplitude in their unattended ear.

In the second phase of the experiment, listeners rated how much they liked each of 12 excerpts, the 6 heard in Phase 1 along with an additional 6 selected randomly from the 12 unheard excerpts, also constrained so that each of the novel excerpts had a different lead instrument. In the third phase, participants rated their recognition confidence for the 6 excerpts from the exposure phase, the 6 that were added to Phase 2, and the 6 remaining (novel) excerpts. The entire procedure lasted approximately 40 min for participants engaged in focused listening and approximately 30 min for participants engaged in incidental listening.

Results and Discussion

As in Experiment 1, we calculated four average liking ratings and five average memory ratings for each participant (see Figure 3).

Liking. As illustrated in Figure 3, liking ratings formed an inverted U-shaped function of exposure for focused listening but a linear function for incidental listening. Trend analysis confirmed that both linear and quadratic trends interacted with listening condition, $F(1, 38) = 7.51$, $p = .004$, and $F(1, 38) = 12.88$, $p < .001$, respectively. Effect sizes are provided in Table 1.

For focused listening, the quadratic trend was significant, $F(1, 19) = 16.64$, $p < .001$, but the linear trend was not. Ratings increased from baseline to 2 exposures, $t(19) = 2.52$, $p = .021$, and increased again marginally from 2 to 8 exposures, $t(19) = 1.91$, $p = .072$; however, they decreased from 8 to 32 exposures, $t(19) = 2.93$, $p = .009$. After 32 exposures, satiation was so complete that benefits of exposure were no longer apparent. In fact, ratings for these excerpts did not differ from baseline ratings.

For incidental listening, the linear trend was significant, $F(1, 19) = 32.59$, $p < .001$, but the quadratic trend was not. Liking ratings were a monotonic function of exposure, increasing reliably from baseline to 2 exposures, $t(19) = 2.53$, $p = .021$; from 2 to 8 exposures, $t(19) = 2.49$, $p = .022$; and from 8 to 32 exposures, $t(19) = 2.20$, $p = .040$.

Memory. Trend analysis revealed a robust interaction between listening condition and linear improvements in recognition as a function of exposure, $F(1, 38) = 102.77$, $p < .001$. The interaction between condition and quadratic trend was not significant. As shown in Figure 3, recognition confidence increased with exposure in both conditions, although the linear trend was much stronger for focused listening, $F(1, 19) = 268.10$, $p < .001$, than for incidental listening, $F(1, 19) = 13.42$, $p = .002$. Effect sizes for linear and quadratic trends are reported in Table 1.

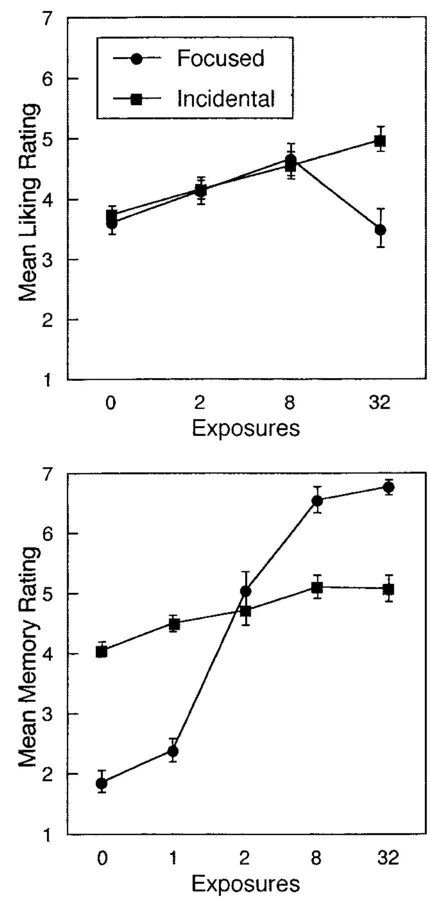

Figure 3. Mean liking and memory ratings in Experiment 2 as a function of exposure frequency and listening condition. Error bars represent standard errors.

For focused listening, average ratings varied from below 2 to almost 7. Recognition confidence was greater for stimuli presented in the second phase relative to baseline, $t(19) = 2.90$, $p = .009$, reflecting participants' false belief that the stimuli had appeared in the exposure phase. Recognition confidence was also greater for stimuli heard twice than for those heard once, $t(19) = 7.72$, $p < .001$; greater for stimuli heard 8 times than for those heard twice, $t(19) = 4.16$, $p < .001$; and marginally greater for stimuli heard 32 rather than 8 times, $t(19) = 2.02$, $p = .058$. There was a modest but significant quadratic trend, $F(1, 19) = 5.03$, $p = .037$, that arose from memory ratings approaching ceiling ($M = 6.55$) after 8 exposures.

For incidental listening, ratings varied from 4 to 5. The only significant difference between adjacent means occurred for excerpts presented once in the second phase relative to baseline, $t(19) = 3.44$, $p = .003$ (i.e., "false" recognition). Means for excerpts heard 2, 8, or 32 times in the exposure phase did not differ, but recognition confidence exceeded baseline levels in each case, $ts(19) = 2.35$, 4.07, and 3.55, respectively, $ps < .03$. Recognition confidence was also higher for excerpts presented 8 or 32 times relative to those falsely recognized, $ts(19) = 2.54$ and 2.33, respectively, *p*s < .04. There was no quadratic trend. Although the significant linear trend confirmed greater recognition confidence with increasing exposure, the changes were small relative to focused listening.

Summary. For focused listening, memory ratings increased dramatically and monotonically as a function of exposure. Liking ratings increased initially but subsequently decreased, revealing reliable satiation for these ecologically valid stimuli. This pattern for the liking data is in line with predictions from the two-factor model, which posits increases in positive affect with increasing exposure until the effect of boredom supersedes the dissipation of neophobia. The two-factor model has no prediction about the memory data, but memory was high when liking was low, which is consistent with the perceptual fluency/attributional model.

For incidental listening, memory ratings increased modestly with exposure. Liking ratings also increased with increasing exposure, in line with the mere exposure effect, albeit without any evidence of satiation (as in Experiment 1). Contrary to predictions from the perceptual fluency/attributional model, increases in recognition accompanied increases in liking.

Experiment 3

Recognition ratings were similar in Experiments 1 and 2, with recognition confidence attenuated greatly for listeners who heard the stimuli incidentally. Striking differences were evident, however, for liking ratings. These differences were most likely due to differences in the ecological validity of the stimuli and methods, which would have made the listening experience more complex and interesting in Experiment 2 than in Experiment 1. Observed differences in liking on the basis of complexity are consistent with Bornstein's (1989) review of the literature and with predictions motivated by the two-factor model (Berlyne, 1970; Stang, 1974). Nonetheless, the experiments differed in other aspects that could have been the source of differential responding, at least in principle. For example, the stimuli varied in duration in Experiment 1 but not in Experiment 2. Other differences included the overall duration of testing sessions, the duration of the interval between consecutive stimuli in the incidental conditions, and the number of presentations in the exposure phase.

The present experiment was designed so that the stimuli and procedure would be intermediate in ecological validity between those of Experiments 1 and 2. Accordingly, we predicted that response patterns for liking ratings would be midway between those of Experiments 1 and 2. Such a finding would confirm that differences among the three experiments are best attributed to differences in ecological validity and stimulus complexity.

Specifically, the stimuli consisted of simple monophonic tone sequences (as in Experiment 1), but all tone sequences were of equal duration (as in Experiment 2). We made the stimulus set as a whole more heterogeneous (and more like Experiment 2) by presenting the sequences on six different musical instruments. In addition, the orienting task for focused listeners was musically relevant, being identical to that of Experiment 2 (i.e., identify the particular musical instrument).

Because the tone sequences of the present experiment were shorter in duration than the orchestral excerpts of Experiment 2, it was impossible to equate the two experiments on total duration of the testing session, number of presentations in the exposure phase, and duration of the interval between stimuli in the exposure phase of the incidental conditions. Moreover, increasing the number of presentations beyond that used in Experiment 1 (maximum of 64) could surpass the threshold of what listeners can tolerate in a single testing session. As a compromise, we made the interval between stimuli in the incidental condition twice as long as it was in Experiment 2, which reduced the difference in total duration between Experiment 2 and the present experiment. If the interval between stimuli was the source of the differences between liking ratings in Experiments 1 and 2, differences between the present experiment and Experiment 1 should be exaggerated (in relation to Experiment 2) rather than attenuated (as predicted).

Method

Participants. The participants were 60 undergraduates who were recruited as in Experiments 1 and 2.

Apparatus and stimuli. The apparatus was the same as in Experiments 1 and 2. The stimuli were 18 of the 30 tone sequences from Experiment 1. To produce 18 sequences of equal duration (i.e., seven tones), we left the seven-tone sequences unchanged and deleted the last tone of the eight-tone sequences and the last two tones of the nine-tone sequences. In contrast to Experiment 1 (i.e., all stimuli played on piano), the stimuli were divided into six sets of 3 sequences, with each set played on a different musical instrument (cello, flute, horn, oboe, piano, or violin). The set of six instruments was the same as the set of lead instruments from Experiment 2. The distracting stimulus in the incidental-listening condition was the same as in Experiments 1 and 2.

Procedure. Half of the participants were assigned to focused listening and half to incidental listening. The procedure was identical to Experiment 2 except that the tone sequences were substituted for the orchestral excerpts and the sequences were presented 4, 16, or 64 times in the exposure phase, separated by 1 s of silence in the incidental-listening condition. The entire procedure lasted approximately 20 min for focused listeners and 15 min for incidental listeners.

Results and Discussion

As in Experiments 1 and 2, we calculated four average liking ratings and five average memory ratings for each participant (see Figure 4).

Liking. Effect sizes derived from a trend analysis are reported in Table 1. The interaction between listening condition and linear increases in liking rating was reliable, $F(1, 58) = 11.20$, $p = .001$, as was the interaction between condition and a quadratic trend, $F(1, 58) = 5.53$, $p = .022$.

For focused listening, the quadratic trend was significant, $F(1, 29) = 7.52$, $p = .010$, but the linear trend was not. As shown in Figure 4, liking ratings formed an inverted U-shaped function of exposure, although the function peaked earlier (at four exposures) and was less exaggerated than in Experiment 2 (see Table 1). For example, the difference between the lowest and the highest mean rating (3.54 and 4.07, respectively) was less than half the magnitude of the same comparison in Experiment 2 (3.50 and 4.65; see Figure 3). Comparisons between adjacent means confirmed that the effect was weak in relation to that in Experiment 2. In fact, the difference between the lowest (baseline) and highest (4 exposures) means was marginal, $t(29) = 1.96$, $p = .060$. Although increases in liking from baseline to 16 exposures were reliable, $t(29) = 2.42$, $p = .022$ (as a result of decreased variance), no other difference between means was significant.

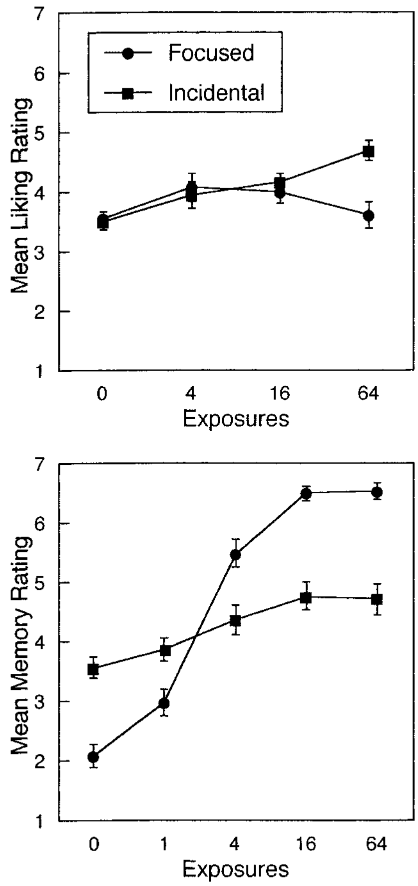

Figure 4. Mean liking and memory ratings in Experiment 3 as a function of exposure frequency and listening condition. Error bars represent standard errors.

For incidental listening, the linear trend in liking ratings was significant, $F(1, 29) = 32.27$, $p < .001$, but there was no quadratic trend. Comparisons between adjacent means revealed that liking ratings were higher for sequences heard 4 times relative to baseline levels, $t(29) = 2.31$, $p = .028$, and higher for sequences heard 64 times than for those heard 16 times, $t(29) = 2.92$, $p = .007$. Only the increase in liking from 4 to 16 exposures was not significant.

To confirm that the change in stimuli and methods influenced response patterns, we conducted a combined analysis of the data from Experiments 1 and 3, with "experiment" as one of the independent variables. The main effect of experiment was not significant, nor was its interaction with listening condition. Nonetheless, there was a three-way interaction involving experiment, listening condition, and quadratic changes in liking as a function of exposure, $F(1, 106) = 5.22$, $p = .024$. The two experiments produced similar response patterns for incidental listening (i.e., significant linear increases in liking as a function of exposure) but not for focused listening. In the present experiment, the focused listeners exhibited a small but significant quadratic trend in liking ratings that was not evident for their counterparts in Experiment 1.

Memory. Trend analysis revealed a robust interaction between listening condition and linear increases in recognition as a function of exposure, $F(1, 58) = 80.32$, $p < .001$. The interaction between condition and a quadratic trend, although weaker, was also significant, $F(1, 58) = 6.66$, $p = .012$. Effect sizes are reported in Table 1.

For focused listening, the linear trend in recognition confidence was dramatic, $F(1, 29) = 396.54$, $p < .001$, as it was in Experiments 1 and 2 (see Figure 4). Memory ratings varied from a low of 2.07 to a high of 6.52. As before, each pair of adjacent means differed significantly, with the exception of excerpts heard 16 and 64 times. Recognition confidence was higher (a) for stimuli heard once in Phase 2 than for baseline stimuli, $t(29) = 6.29$, $p < .001$ (i.e., "false" recognition); (b) for stimuli heard 4 times than for those heard once, $t(29) = 7.90$, $p < .001$; and (c) for those heard 16 times than for those heard 4 times, $t(29) = 4.23$, $p < .001$. The quadratic trend was also significant, $F(1, 29) = 22.15$, $p < .001$, as it was in Experiments 1 and 2, because memory ratings reached ceiling levels after 16 exposures ($M = 6.48$).

For incidental listening, recognition confidence increased linearly, $F(1, 29) = 15.27$, $p < .001$, although the increase was greatly attenuated relative to focused listening, as it was in Experiments 1 and 2. The quadratic trend was not reliable. There were no reliable differences between adjacent means, although the difference in recognition confidence between sequences heard 4 times and those heard once in the liking phase was marginal, $t(29) = 1.90$, $p = .068$. Recognition confidence also exceeded baseline levels for excerpts presented 4, 16, and 64 times, respectively, $t(29) = 2.49$, $p = .019$; $t(29) = 4.36$, $p < .001$; and $t(29) = 3.61$, $p = .001$. Overall, the means varied over a relatively narrow range, from a low of 3.56 (baseline) to a high of 4.75 (16 exposures).

Joint analysis of the present memory data and those from Experiment 1 confirmed that there was no main effect of experiment and no interactions involving differences between experiments, with one exception. There was a reliable three-way interaction involving experiment, listening condition, and linear increases in memory as a function of exposure, $F(1, 106) = 6.88$, $p = .010$. This finding confirms that response patterns differed for memory ratings across the two experiments. Specifically, the two-way interaction between listening condition and linear increases in recognition confidence was stronger in Experiment 1 than in Experiment 3. In Experiment 1, the linear trend was significant in the focused condition but not in the incidental condition. In the present experiment, although the linear trend was relatively weak in the incidental condition, it was significant in both conditions, as it was in Experiment 2. Presumably, the homogeneous stimulus set of Experiment 1 (i.e., all sequences played on piano) made it difficult for listeners in the incidental condition to discriminate novel from previously heard sequences, whereas the heterogeneous set of the present experiment facilitated discrimination.

Summary. As predicted, response patterns for liking ratings were midway between those observed in Experiments 1 and 2, which provides support for the hypothesis that response patterns are influenced by the ecological validity of the stimuli and method. Specifically, liking ratings in the focused condition of Experiment 1 did not vary as a function of number of exposures, whereas ratings in Experiment 2 formed an inverted U-shaped function—as predicted by the two-factor model—with an initial increase followed by a decrease. In the present experiment, ratings from listeners in the focused condition also formed an inverted U, but the increase and subsequent decrease were smaller than those witnessed in Experiment 2. In fact, the effect size of the quadratic trend was less than half the magnitude of the effect in Experiment 2 (see Table 1). The difference between experiments in the time course of the satiation effect was also consistent with the two-factor model's prediction that the entire liking trajectory (i.e., increases and decreases as a function of exposure) should be more rapid for simple than for complex stimuli.

As in Experiments 1 and 2, liking data in the incidental conditions exhibited increases with increasing exposure with no evidence of satiation, in line with the original mere exposure hypothesis. More important, changes in liking ratings were midway between those of Experiments 1 and 2: The function was weakest in Experiment 1, strongest in Experiment 2, and intermediate in the present experiment. For example, no adjacent means differed significantly in Experiment 1, two of three comparisons were significant in the present experiment, and all comparisons were significant in Experiment 2. Moreover, the effect size of the linear trend in the present experiment was midway between effect sizes from Experiments 1 and 2 (see Table 1).

For the most part, recognition ratings were similar to those from Experiments 1 and 2. For focused listeners, recognition confidence increased dramatically as a function of exposure. For incidental listeners, recognition confidence was consistently attenuated. Linear increases in explicit memory as a function of incidental exposure were reliable in the present experiment and in Experiment 2 but not in Experiment 1. The effect sizes reported in Table 1 suggest that the association between recognition and incidental exposure becomes stronger as the to-be-remembered stimuli increase in complexity and ecological validity.

General Discussion

We examined liking and memory for musical stimuli as a function of number of previous exposures. Our findings are notable in at least four respects. First, the effect of exposure on preference varied with the ecological validity of the stimuli. Second, ecological validity also affected how liking and memory covaried as a function of exposure. Third, high levels of recognition confidence were associated with lower evaluations of the stimuli. Finally, we found evidence of reliable satiation effects in the laboratory that mirror real-life experience.

In Experiment 1, focused listening led to liking ratings that were independent of exposure but to memory ratings that increased monotonically with increasing exposure (see Figure 2). By contrast, incidental listening led to liking ratings that increased monotonically with exposure but to memory ratings that were independent of exposure. These response patterns for our supraliminal stimuli mirror those reported with subliminal exposure (Zajonc, 2001). They also provide support for the proposal that listeners' evaluation of musical stimuli is independent of explicit memory (Peretz, Gaudreau, & Bonnel, 1998). Indeed, the findings are consistent with neuropsychological evidence of general dissociations between cognitive and affective responses to music. For example, a patient tested by Peretz and her colleagues could classify happy-sounding and sad-sounding tunes correctly, but she could not recognize familiar tunes or discriminate gross changes in pitch contour (Peretz, 2001; Peretz & Gagnon, 1999; Peretz, Gagnon, & Bouchard, 1998).

Patterns of evaluation and recognition were quite different in Experiments 2 and 3. After focused listening, liking ratings formed an inverted U-shaped function of exposure, but memory ratings increased linearly (see Figures 3 and 4). After incidental listening, liking *and* memory ratings increased linearly with exposure, although increases in recognition confidence were much smaller than they were for focused listening. Of particular interest was the attenuation of liking in the context of high levels of recognition confidence. This finding was also evident among focused listeners in Experiment 1; low but not high levels of recognition confidence were accompanied by increases in liking. These results are consistent with predictions from the perceptual fluency/attributional model but inconsistent with proposals of independence between cognitive and affective responding (Peretz, Gaudreau, & Bonnel, 1998; Zajonc, 1980, 2001).

Other findings contradict the perceptual fluency/attributional model. The model predicts decreases in stimulus evaluation with increasing recognition accuracy, but in listening contexts with ecological validity (Experiments 2 and 3), increased exposure led to increases in both liking and recognition. In fact, in a context with intermediate ecological validity (Experiment 3), as few as four exposures led to an increase in recognition *and* a subtle increase in liking. In our most ecologically valid stimulus contexts (Experiment 2), as few as two exposures led to enhanced memory and evaluation relative to novel stimuli. Similarly, our incidental task in Experiments 2 and 3 produced monotonic increases in liking as a function of exposure frequency as well as small but reliable increases in recognition confidence. Thus, in ecologically valid stimulus contexts, repetition led to greater liking as well as increased recognition. The negative association between liking and memory predicted by the perceptual fluency/attributional model became evident only when recognition confidence was extremely high.

To date, robust satiation effects such as the one discovered in Experiment 2 have been found infrequently. For focused listeners, liking ratings increased reliably from baseline to 8 exposures, falling to baseline levels after 32 exposures. Similar but smaller increases and decreases in liking were evident in Experiment 3. These findings are unique in providing unequivocal evidence of satiation for musical stimuli in a controlled experimental setting.

The robust satiation effect in Experiment 2 cannot be attributed simply to amount of exposure. Participants in Experiments 1 and 3 had twice as many exposures as did those in Experiment 2, but they showed either no evidence of satiation (Experiment 1) or a smaller effect (Experiment 3). Our data indicate that satiation effects are more likely to result from repeated exposures to complex, ecologically valid stimuli than from repetition of simple stimuli. Why should this be the case? One possibility is that the degree to which liking initially increases is the best predictor of subsequent decreases. In the present study, the largest amount of satiation was evident after the largest initial increases in liking (i.e., from 0 to 8 exposures, Experiment 2, focused listening). In other words, complex stimuli may engender relatively large increases in liking as a function of exposure, and substantial increases in liking may be a prerequisite for substantial decreases.

Recent data from the visual domain provide evidence consistent with this perspective. Event-related brain potentials reveal that perceptual encoding of "affect-laden" stimuli (i.e., those likely to induce affective responding) is facilitated relative to encoding of neutral stimuli (Schupp, Junghöfer, Weike, & Hamm, 2003). On the one hand, then, perception of stimuli with affective potential may be inherently fluent relative to neutral stimuli. On the other hand, perceptual fluency increases affective responding. In other words, the association between affect and exposure may be somewhat circular. In the present study, it seems safe to assume that stimuli with greater ecological validity were also the most affect laden, which would have exaggerated fluency effects of exposure and increased the possibility of greater increases and decreases in liking. Presumably, our "real music" stimuli of Experiment 2 were intrinsically more likeable than the somewhat impoverished stimuli of Experiment 3, which were more likeable than the very impoverished stimuli of Experiment 1.[1] This also means that liking as a function of exposure in the experiments would have proceeded from different baseline levels. In most of the relevant research (Bornstein, 1989; Zajonc, 2001), stimuli are initially neutral with respect to affect before the exposure phase. Interestingly, in one instance in which aesthetically pleasing stimuli (artworks) were presented (Zajonc et al., 1972), satiation effects were similarly robust to the one observed in Experiment 2.

Conclusions about differential responding based on stimulus complexity and ecological validity remain somewhat speculative, however, until further data are collected. Stimuli for our three experiments differed in multiple ways (e.g., timbre, texture, typicality, and aesthetic value) that may be separate from, or interact with, overall complexity. Any combination of these variables could have contributed to differences in responding among experiments.

Regardless, our results highlight the strengths and weaknesses of the various theoretical perspectives that purport to explain associations between exposure and liking. Zajonc's (2001) account is not intended to account for supraliminally presented stimuli that may be remembered as well as liked or disliked. Both the perceptual fluency/attributional model and the two-factor model account for some of the data reported here, yet neither explains all of the results adequately. To summarize, the perceptual fluency/attributional model accounts for dissociations between liking and explicit memory as well as for all cases of reduced liking that were accompanied by increases in recognition confidence. It fails, however, to account for increases in liking that accompanied increases in recognition confidence. The two-factor model accounts for the satiation effects we observed, as well as for the increases in recognition confidence and liking that occurred simultaneously. It fails, however, to account for contexts in which liking and memory were independent. Thus, a hybrid of the two approaches (see also Bornstein, 1989) may provide the best account of associations among exposure, liking, and memory.

Our proposed hybrid model makes a distinction between impoverished, simple, and affectively neutral stimuli, on the one hand, and ecologically valid, rich, and affect-laden stimuli, on the other hand. When the former are presented subliminally or supraliminally, previous exposure to such stimuli increases their perceptual fluency. In the absence of explicit memory for the stimuli, participants are likely to misattribute this fluency to any dimension introduced by the experimenter (e.g., liking or brightness). When they remember the stimuli explicitly, however, they have an adequate explanation available for fluency effects, which they attribute correctly to previous exposure. For ecologically valid stimuli that may have preexisting affective status, increased exposure initially corresponds with relatively large increases in liking as well as improved memory. Presumably, part of this exposure process includes increasing familiarity with the higher order structure of the stimuli, which allows the perceiver to appreciate their structural complexity. As exposure increases to the point at which the perceiver has nothing left to learn, boredom sets in and satiation begins.

A central goal of the present study was to improve our understanding of how repeated exposure to rich and meaningful stimuli influences how they are liked and remembered. Our results reveal that controlled laboratory experiments can produce findings that are consistent with the increases and decreases in liking for music that characterize phenomenological experience. Our findings also point to ways in which theories of exposure and liking might be modified and improved. A good theory should be able to explain responses to impoverished, highly controlled, affectively neutral stimuli, as well as responses to complex, ecologically valid, and affect-laden stimuli that people encounter regularly in their daily lives.

Our interest in effects of repeated exposure to complex stimuli in general, and to artworks in particular, parallels the approach taken by Cutting (2003). Cutting found that mere exposure effects can explain how a canon of classic French Impressionist paintings is promoted and maintained. Several years earlier, Berlyne noted that the goal of his new experimental aesthetics was "not only to throw light on aesthetic phenomena but, through the elucidation of aesthetic problems, to throw light on human psychology in general" (1974, p. 5). Thirty years later, we believe that this goal remains laudable. Future studies of exposure and liking for complex, real-world stimuli are bound to improve our understanding of associations among exposure, liking, and memory that are central to human experience.

[1] As illustrated in Figures 2, 3, and 4, differences across experiments in the absolute magnitude of liking ratings were relatively small. Presumably, ratings were context dependent and made in relation to the particular stimulus set as a whole. We would expect larger differences if the same participants heard tone sequences (Experiments 1 and 3) *and* orchestral excerpts (Experiment 2).

References

Barchas, P. R., & Perlaki, K. M. (1986). Processing of preconsciously acquired information measured by hemispheric asymmetry and selection accuracy. *Behavioral Neuroscience, 100,* 343–349.

Bartlett, D. L. (1973). Effect of repeated listenings on structural discrimination and affective response. *Journal of Research in Music Education, 21,* 302–317.

Berlyne, D. E. (1970). Novelty, complexity, and hedonic value. *Perception & Psychophysics, 8,* 279–286.

Berlyne, D. E. (1974). The new experimental aesthetics. In D. E. Berlyne (Ed.), *Studies in the new experimental aesthetics* (pp. 1–25). Washington, DC: Hemisphere.

Bonanno, G. A., & Stillings, N. A. (1986). Preference, familiarity, and recognition after repeated brief exposures to random geometric shapes. *American Journal of Psychology, 99,* 403–415.

Bornstein, R. F. (1989). Exposure and affect: Overview and meta-analysis of research, 1968–1987. *Psychological Bulletin, 106,* 265–289.

Bornstein, R. F. (1992). Inhibitory effects of awareness on affective responding. In M. S. Clark (Ed.), *Emotion: Review of personality and social psychology* (No. 13, pp. 235–255). Thousand Oaks, CA: Sage.

Bornstein, R. F., & D'Agostino, P. R. (1992). Stimulus recognition and the mere exposure effect. *Journal of Personality and Social Psychology, 63,* 545–552.

Bornstein, R. F., & D'Agostino, P. R. (1994). The attribution and discounting of perceptual fluency: Preliminary tests of a perceptual fluency/attributional model of the mere exposure effect. *Social Cognition, 12,* 103–128.

Bornstein, R. F., Kale, A. R., & Cornell, K. R. (1990). Boredom as a limiting condition on the mere exposure effect. *Journal of Personality and Social Psychology, 58,* 791–800.

Bornstein, R. F., Leone, D. R., & Galley, D. J. (1987). The generalizability of subliminal mere exposure effects: Influence of stimuli perceived without awareness on social behavior. *Journal of Personality and Social Psychology, 53,* 1070–1079.

Bradley, I. L. (1971). Repetition as a factor in the development of musical preferences. *Journal of Research in Music Education, 19,* 295–298.

Brentar, J. E., Neuendorf, K. A., & Armstrong, G. B. (1994). Exposure effects and affective responses to music. *Communication Monographs, 61,* 161–181.

Brickman, P., & D'Amato, B. (1975). Exposure effects in a free choice situation. *Journal of Personality and Social Psychology, 32,* 415–420.

Cohen, J. D., MacWhinney, B., Flatt, M., & Provost, J. (1993). PsyScope: A new graphic interactive environment for designing psychology experiments. *Behavior Research Methods, Instruments, & Computers, 25,* 257–271.

Cutting, J. E. (2003). Gustave Caillebotte, French Impressionism, and mere exposure. *Psychonomic Bulletin & Review, 10,* 319–343.

Downey, J. E., & Knapp, G. E. (1927). The effect on a musical programme of familiarity and of sequence of selections. In M. Schoen (Ed.), *The effects of music* (pp. 223–242). New York: Harcourt, Brace.

Gilliland, A. R., & Moore, H. T. (1927). The immediate and long-time effects of classical and popular phonograph selections. In M. Schoen (Ed.), *The effects of music* (pp. 211–222). New York: Harcourt, Brace.

Hargreaves, D. J. (1984). The effects of repetition on liking for music. *Journal of Research in Music Education, 32,* 35–47.

Heingartner, A., & Hall, J. V. (1974). Affective consequences in adults and children of repeated exposure to auditory stimuli. *Journal of Personality and Social Psychology, 29,* 719–723.

Heyduk, R. G. (1975). Rated preference for musical compositions as it relates to complexity and exposure frequency. *Perception & Psychophysics, 17,* 84–91.

Jacoby, L. L. (1983). Perceptual enhancement: Persistent effects of an experience. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 21–38.

Jacoby, L. L., & Kelly, C. M. (1987). Unconscious influences of memory for a prior event. *Personality and Social Psychology Bulletin, 13,* 314–336.

Jacoby, L. L., & Whitehouse, K. (1989). An illusion of memory: False recognition influenced by unconscious perception. *Journal of Experimental Psychology: General, 118,* 126–135.

Jakobovits, I. A. (1966). Studies of fads: I. The "Hit Parade." *Psychological Reports, 18,* 443–450.

Kail, R. V., Jr., & Freeman, H. R. (1973). Sequence redundancy, rating dimensions, and the exposure effect. *Memory & Cognition, 1,* 454–458.

Kalat, J. W., & Rozin, P. (1973). "Learned safety" as a mechanism in long-delay taste-aversion learning in rats. *Journal of Comparative and Physiological Psychology, 83,* 198–207.

King, S. (1996). *The green mile: Night journey.* New York: Penguin Audiobooks.

Krugman, H. F. (1943). Affective responses to music as a function of familiarity. *Journal of Abnormal and Social Psychology, 38,* 388–392.

Kunst-Wilson, W. R., & Zajonc, R. B. (1980). Affective discrimination of stimuli that cannot be recognized. *Science, 207,* 557–558.

Mandler, G., Nakamura, Y., & Van Zandt, B. J. (1987). Nonspecific effects of exposure on stimuli that cannot be recognized. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 13,* 646–648.

Meyer, M. (1903). Experimental studies in the psychology of music. *American Journal of Psychology, 14,* 456–478.

Monahan, J. L., Murphy, S. T., & Zajonc, R. B. (2000). Subliminal mere exposure: Specific, general, and diffuse effects. *Psychological Science, 11,* 462–466.

Mull, H. K. (1957). The effect of repetition upon the enjoyment of modern music. *Journal of Psychology, 43,* 155–162.

Murphy, S. T., Monahan, J. L., & Zajonc, R. B. (1995). Additivity of nonconscious affect: Combined effects of priming and exposure. *Journal of Personality and Social Psychology, 69,* 589–602.

Obermiller, C. (1985). Varieties of mere exposure: The effects of processing style and repetition on affective responses. *Journal of Consumer Research, 12,* 17–30.

Peretz, I. (2001). Listen to the brain: A biological perspective on musical emotions. In P. N. Juslin & J. A. Sloboda (Eds.), *Music and emotion: Theory and research* (pp. 105–134). Oxford, England: Oxford University Press.

Peretz, I., & Gagnon, L. (1999). Dissociation between recognition and emotional judgments for melodies. *Neurocase, 5,* 21–30.

Peretz, I., Gagnon, L., & Bouchard, B. (1998). Music and emotion: Perceptual determinants, immediacy, and isolation after brain damage. *Cognition, 68,* 111–141.

Peretz, I., Gaudreau, D., & Bonnel, A. M. (1998). Exposure effects on music preferences and recognition. *Memory & Cognition, 15,* 379–388.

Schupp, H. T., Junghöfer, M., Weike, A. I., & Hamm, A. O. (2003). Emotional facilitation of sensory processing in the visual cortex. *Psychological Science, 14,* 7–13.

Seamon, J. G., Brody, N., & Kauff, D. M. (1983). Affective discrimination of stimuli that are not recognized: Effects of shadowing, masking, and cerebral laterality. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 9,* 544–555.

Seamon, J. G., Marsh, R. L., & Brody, N. (1984). Critical importance of exposure duration for affective discrimination of stimuli that are not recognized. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 10,* 465–469.

Seamon, J. G., Williams, P. C., Crowley, M. J., Kim, I. J., Langer, S. A., Orne, P. J., & Wishengrad, D. L. (1995). The mere exposure effect is based on implicit memory: Effects of stimulus type, encoding conditions, and number of exposures on recognition and affect judgments. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21,* 711–721.

Sloboda, J. A., O'Neill, S. A., & Ivaldi, A. (2001). Functions of music in everyday life: An exploratory study using the experience sampling method. *Musicae Scientae, 5,* 9–32.

Stang, D. J. (1974). Methodological factors in mere exposure research. *Psychological Bulletin, 81,* 1014–1025.

Stang, D. J., & O'Connell, E. J. (1974). Computer as experimenter in social psychological research. *Behavior Research Methods and Instrumentation, 6,* 223–231.

Thompson, W. F., Balkwill, L.-L., & Vernescu, R. (2000). Expectancies generated by recent exposure to melodic sequences. *Memory & Cognition, 28,* 547–555.

Verveer, E. M., Barry, H., & Bousfield, W. A. (1933). Change in affectivity with repetition. *American Journal of Psychology, 45,* 130–134.

Washburn, M. F., Child, M. S., & Abel, T. M. (1927). The effects of immediate repetition on the pleasantness or unpleasantness of music. In M. Schoen (Ed.), *The effects of music* (pp. 199–210). New York: Harcourt, Brace.

Whittlesea, B. W., & Price, J. R. (2001). Implicit/explicit memory versus

analytic/nonanalytic processing: Rethinking the mere exposure effect. *Memory & Cognition, 29,* 234–246.
Wilson, W. R. (1979). Feeling more than we can know: Exposure effects without learning. *Journal of Personality and Social Psychology, 37,* 811–821.
Zajonc, R. B. (1968). Attitudinal effects of mere exposure. *Journal of Personality and Social Psychology Monographs, 9*(2, Pt. 2), 1–27.
Zajonc, R. B. (1980). Feeling and thinking: Preferences need no inferences. *American Psychologist, 35,* 151–175.
Zajonc, R. B. (2001). Mere exposure: A gateway to the subliminal. *Current Directions in Psychological Science, 10,* 224–228.
Zajonc, R. B., Crandall, R., Kail, R. V., & Swap, W. (1974). Effect of extreme exposure frequencies on different affective ratings of stimuli. *Perceptual and Motor Skills, 38,* 667–678.
Zajonc, R. C., Shaver, P., Tavris, C., & van Kreveld, D. (1972). Exposure, satiation and stimulus discriminability. *Journal of Personality and Social Psychology, 21,* 270–280.
Zajonc, R. B., Swap, W. C., Harrison, A. A., & Roberts, P. (1971). Limiting conditions of the exposure effect: Satiation and relativity. *Journal of Personality and Social Psychology, 18,* 384–391.

Received December 24, 2002
Revision received August 18, 2003
Accepted August 22, 2003 ■