Physical and Psychological Effects from Supervised Aerobic Music Exercise

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***Objectives*: To assess the physical and psychological effects across 11 weeks of music-exercise sessions, the participants' training experience, and attitudes towards physical activity. The effect of different music information was also investigated. *Methods*: Overall, 146 sedentary volunteers were randomized into 4 exercise groups and each group received different music information. Physical capacity and psychological measures were obtained. *Results*: Increased performance in oxygen uptake and flexibility and decreased blood pressure was found. Participants reported increased wellbeing and body-awareness, and an intention to remain physically active. No differences between groups were found. *Conclusion*: Music-exercise can be recommended to promote physical activity among sedentary individuals. The amount of musical information in synchronous music seems not to have any effects on self-selected intensity or physiological benefits.**

***Key words*: exercise intensity, physical capacity, health, physical activity prescription, life style**

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Physical activity (PA) is of utmost importance for health, longevity, and high quality of life.[1] In many industrialized countries, the overall level of physical activity in the general population remains too low to reach general health goals. In this light, 2 important questions emerge: (1) Which type and amount of exercise is necessary and sufficient to reach such goals? and, (2) How does one motivate people to participate in it? Substantial societal resources are spent on promoting physical activity, primarily by means of information campaigns. Nevertheless, living habits have changed little in recent years. One third of the population is still not physically active on a daily basis as existing recommendations advise.[2] Thus, current understanding of the factors that motivate people is insufficient to bring about the necessary change.

Greater understanding is needed concerning factors that facilitate physical activity, particularly ones that motivate people to commence and sustain it. Included among these factors are how attractive and rewarding the activity itself is, and how perceptions of one's own need for physical activity intersects with one's perceived ability to engage in the activity.

Much physical activity is accompanied by music, indicating that people find listening to music beneficial. Supervised aerobic exercise to music (music-exercise for short) is a form of group exercise that covers cardiovascular conditioning, strength training, and flexibility exercises. It is a popular form of exercise, in particular for people who have been physically inactive. In this type of exercise, it is suggested that music can increase the effect of exercise.[3] Namely, music can lower perceptions of exertion, thereby increasing the amount of work performed without the shift towards negative feeling states typically associated with more intense exercise.[4] It has been shown that the effect is greatest if the music is self-selected and motivational,[3] but in group activities the music is, by necessity, selected by the instructor and not the participants. The music in music-exercise is chosen so that the exercises can be performed in rhythm with the music. Apart from this, there is little information about what should be focused on in the music selection procedures. Because intrinsic motivation (by way of self-selected music) is not something we can easily manipulate in music-exercise, we decided to try to manipulate the other obvious factor, namely the properties of the music. To find fundamental characteristics that elicit positive responses among persons engaged in exercise, we used preselected music but changed the conditions within the music by stripping away various amounts of musical

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content for the 4 different groups. We hypothesized that this would affect the motivation to perform which we could assess by comparing post-tests to pre-tests.

Physical activity improves cardiovascular conditioning and musculoskeletal health.[1,5-7] Cardiovascular fitness improvement depends upon how often exercises are performed, as well as the duration and the intensity of exercise. The American College of Sports Medicine (ACSM)[5,8] recommends intensity between 55% and 65% to 90% of maximum heart rate (HR) when exercising. For strength training, ACSM[8] recommends a minimum of 8 to 10 exercises that train the major muscle groups, with exercises performed through a full range of motion or in the maximum range of motion that does not elicit pain or discomfort.

What remains unclear from previous research is the training intensity people with a sedentary lifestyle select during music-exercise. In an earlier study including adult habitual walkers, Spelman et al[9] found that their average walking intensity was 70% of HR max; among high-active as well as low-active male students, Dishman et al[10] found that the average self-selected intensity on a cycle ergometer was 62% of VO_2 max. Furthermore, it is poorly understood to what extent participating in music-exercise affects the motivation to continue being physically active. Studies of the motivation for physical activity have focused mostly on social-cognitive factors such as perceived benefits and barriers for exercising. The motivational powers of the exercise itself, or, as in this case, an integral part of it – music - is rarely considered. Therefore, we sought to clarify the effects of music-exercise on the willingness to remain physically active. At pre-test, none of the participants was physically active and we could not, therefore, ask them about their willingness to remain physically active at that time, for obvious reasons. First, it would be begging the question, inasmuch as they had just signed up to be physically active. Second, they had little experience of what it would mean to them, so any answers would have been speculative. Thirdly, the value of pre- and post-measures would be difficult to interpret, because they may well underestimate the effort, time expenditure, and pain before the exercise actually began.

The aim of the study was to assess the physical and psychological effects across the whole period of 11 weeks of bi-weekly music-exercise sessions, the participants' training behavior and experience, and their attitudes towards continuing to be physically active. We also evaluated the effects of different music information on observed outcomes. Specifically, we hypothesized that participating in bi-weekly exercise for 11 weeks brings measurable effects upon physical capacity and blood pressure and increases future motivation for being physically active. We also expected that many participants would train within the effective range.

METHODS

Participants

An invitation was sent out through mailing lists targeting employees at the University of Umeå and Umeå University Hospital. We invited healthy adults between 18 and 65 years of age who had led a sedentary life style, and who were willing to participate in aerobic exercise sessions for 11 weeks including some extra measurement and rating procedures. They were required not to have exercised or have been more than moderately physically active for more than once a week during the previous 12 months. Participants with chronic pain or illnesses were excluded. Prospective participants applied via an online application form where they also answered questions regarding individual characteristics, level and types of physical activity, and medical issues. The Web interface provided general information about the study. Overall, 206 people applied to participate. Some applicants were excluded because they failed to meet one or more inclusion criteria; other applicants declined to continue their participation for various reasons, mostly because of conflicting work schedules. Therefore, they were not included in the randomization or in any analyses. This left 123 eligible women and 23 men who were scheduled for the physical pre-test. We used an *ad hoc* determined sample size based on available number of participants, after applying the above mentioned inclusion criteria. All participants gave written informed consent before commencing the study.

Design

We combined a study-comparison design to evaluate the effects of music-exercise generally with a between-participants design to examine the effects of different music information. We considered it unfeasible to assign people to a non-activity group after volunteering to partake in music-exercise, so the comparison group (25 men and 25 women) was formed by healthy adults who led a sedentary life style and who had also signed up as a comparison group for a different study, focusing on back pain. The comparison group was asked to live life "as usual" and was only used in our study to compare physical changes at the start and end of the 11-week exercise period.

The duration of the study was chosen as a compromise between the commitment expected from the participants - due to a rigid schedule including fixed exercise times (often during work hours), to which participants had to adhere - and the minimal amount of exercise expected to yield statistically significant results.[7]

The purposes of the study were not disclosed to the participants and they were not informed about the differences when it came to musical content among the groups, nor was the purpose of the music manipulation disclosed to the instructors. Each exercise session was led by one of 4 physiotherapists. The instructors rehearsed the training program together and were rotated among the groups to avoid an "instructor effect."

Group Assignment and Music Stimuli

All recruiting, randomization, and participation contact was carried out by a research assistant. The participants were evenly distributed by random assignment into 4 exercise groups. After screening according to the inclusion criteria, each participant was given a pseudorandom integer value in Statistica (StatSoft Inc, USA) using the function "Fill random values." All participants were then sorted according to the random values, from smallest to largest number. The resulting list was divided according to sex and the first quartile of men and women were assigned to group 1; the next quartile was assigned to group 2, and so forth. Ultimately, each group of randomly selected participants had a proportional distribution of men and women. No differences in descriptive statistics were found among randomized groups

Because we wanted to test possible physiological and psychological effects of musical content on participants, we selected a playlist suitable for 1 hour of music-exercise, consisting of 14 commercially available songs with limited dissemination to the public, such that most participants would be unfamiliar with them. This playlist was than edited using the PC sequencer software program Cubase 5 (Steinberg, Germany) to construct 3 versions with varying musical information but with the same duration, tempo, and rhythmic structure as the original songs. Group 4 exercised to the original 14 songs. Group 3 heard synthesized versions designed to replicate the essential musical structure of the original songs, but not every minute in detail. In particular they were not exposed to typical characteristics of human performance in terms of dynamics (local variation in loudness) and micro-timing. Recorded voices were replaced by synthesized voices with saxophone or other brass timbre. Group 2 heard versions of the synthesized music in which all instrument voices carrying pitch information were removed, such that only the rhythmic patterns of the drum accompaniment was preserved. Group 1 heard still more simplified versions of the rhythmic patterns heard by Group 2, rendering it similar to a drum machine track. Excerpts of the audio files of all sound stimuli are available at https://umu.box.com/audioexcerpts.

Materials and Procedures

A wide range of dependent measures was obtained that were expected to reflect both long-term and short-term health and fitness indicators (Figure 1). They were administered according to 4 different regimes: (1) pre-test and post-test measures at the beginning and end of the exercise period, (2) psychological measures at arbitrary times throughout the exercise period, (3) work intensity and perceived exertion measures during and after each exercise session, and (4) instruments administered only post-exercise.

Exercise Sessions

The instructors were careful to allow participants to adapt gradually to the exercises, and to increase the difficulty and intensity progressively over the first 6 sessions. Participants were encouraged to report any pain or discomfort. The sessions began with warm-up exercises for 10 minutes, followed by 50 minutes of cardiovascular, strength, flexibility, and core training exercises. The exercises for cardiovascular fitness included jogging and various combinations of low impact exercises such as lunge, step-touch, step-knee, and side-to-side movements. The strength exercises were designed to improve both functional strength and core stability and included standing squats and lunges, supine crunches and hip lift, prone superman, the bridge and side-bridge, push-ups, and standing barbell and dumbbell exercises. The flexibility part aimed at increasing flexibility and body awareness by means of exercises performed with an optimal movement pattern. These motions included walking quadriceps stretch and backward lunges. All exercises were performed synchronously with the music.

The music was played through a Philips mp3-player from mp3-files, in which the real music and the current stimulus music were contained in each of the 2 stereo channels. The left channel was connected to a transmitter that sent a radio signal to a wireless receiver on the instructor's body, which played the real music (same that was given to Group 4) through tightly fitting ear buds that cut out external sounds, so that the music manipulation would not affect the instructors' behavior. The right channel was connected to the public address loudspeaker system providing the participants with the auditory stimuli selected for their group.

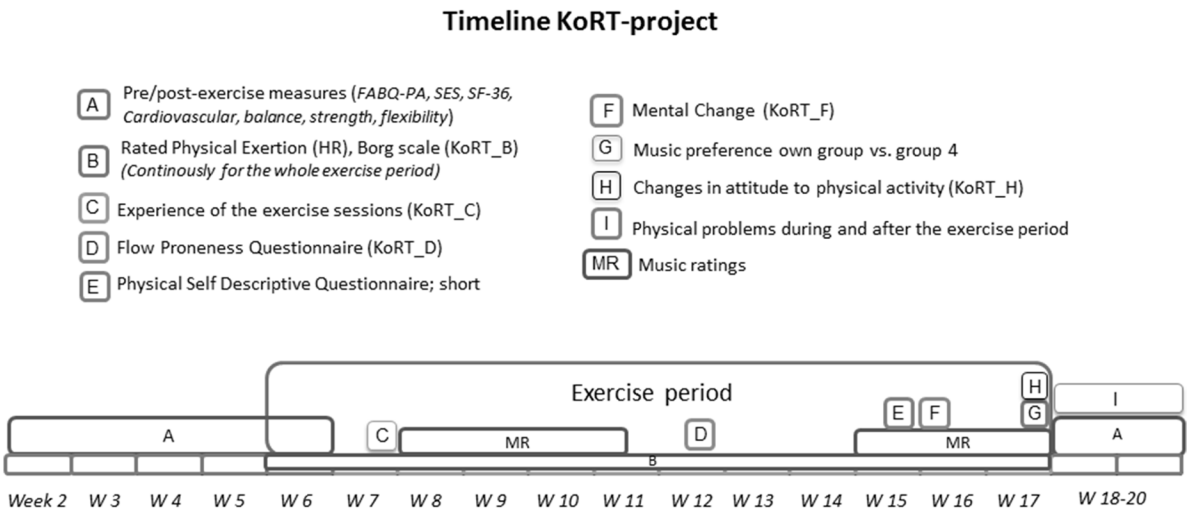
The exercise sessions took place at a facility that supplied the exercise equipment. In addition to the instructor, an experimenter was present at all times during the sessions to administer the pulse belts, to make sure they worked correctly, to monitor the Activio system, and to administer the rating scales.

Pre- and Post-exercise Measures

The pre-test session began with participants completing the questionnaires, followed by interviews during which it was confirmed that participants had not taken heavy physical exercise during the preceding day and had not smoked, eaten or drunk any caffeine-containing refreshments during the past 3 hours. Body height and weight were measured and after a 10-minute rest, blood pressure was recorded in a sitting position by an Omron M4 blood pressure monitor (Omron Matsusaka Co., Matsusaka, Mie, Japan). Physical performance testing followed these procedures. The pre-tests also included a screening about participants' medical history, particularly in regard to cardiovascular or muscular contraindications to participation.

Fear-avoidance beliefs questionnaire (FABQ). The FABQ[11] consists of 16 items and is divided

Figure 1
Flowchart of the Study



into 2 subscales; fear-avoidance beliefs for work (FABQ_Work) with 11 items and fear avoidance beliefs for physical activity (FABQ_PA). The items are scored on a 7-point Likert scale (strongly disagree to strongly agree). The score of each subscale is used independently; in the present study only the 5 items of the FABQ_PA were used. These 5 items are summed to a score (0-30), with a higher score reflecting higher avoidance. FABQ was originally developed for patients with back pain, which is why the word "back" in the survey has been replaced with "joints and muscles."

Self-efficacy Scale. The Self Efficacy Scale (SES)[12] is a 20 item-scale which was originally designed to assess the confidence in performing daily activities among patients with low back pain. The maximum score is 200, with higher scores reflecting higher confidence. The reliability of the SES is high, with Cronbach's alpha internal consistency coefficient of .94.[12]

Health related quality of life. The Swedish version of the SF-36 Health Survey was used for assessing self-reported health-related quality of life.[13] The questionnaire contains 36 items and addresses 8 health domains: physical functioning (PF), role limitations due to physical health (RP), bodily pain (BP), general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH). The domains vary from 1 to 100 with a high value representing a positive health. The SF-36 was also answered at post-test.

Physical performance testing. The selection of physical performance tests was based on their being standardized, reliable, and easy-to-use in a clinical setting. The tests were performed in a standardized sequence and environmental conditions were kept as constant as possible across test sessions. Flexibility in combination with movement control was evaluated by the Selective Functional Movement Assessment (SFMA).[14] The SFMA consists of 7 full-body movement tests (4 of them are performed to the left and right side = 11 tests) designed to assess fundamental movement patterns (forward and backward bending of the spine, rotation of hips and low back, standing on one leg, squatting with arms extended over head, reaching for the opposite scapula angulus superior and angulus inferior behind the head respectively behind the back). Each test received one point if it was performed optimally and without pain, and tests were summed to a maximum of 11 points. The test had an inter-rater reliability (r_s) of .95 when it was examined on 20 subjects in a pilot project before the study started.

To estimate maximal oxygen uptake (VO_2 max) we used a submaximal test[15] on a cycle ergometer (model 818E, Monark, Vansbro, Sweden). Heart rate (HR) was registered with a Polar Sport tester (Polar Electro, Kempele, Finland). The test protocol included 3 or 4 phases of at least 4 minutes each with increasing load in watts (W), depending on the individual's physical activity level, body weight, sex, and age. The load was increased when the participant had reached a steady state in HR for at least 3 minutes. Heart rate was recorded at the end of every test minute, as was a rating of perceived exertion (RPE) using the 6-20 Borg scale. The test was terminated if the participant's heart rate exceeded 75% of the age predicted maximum,

Borg scale rating >16, or if the tester observed the participant being distressed. If 70% of the age-predicted HR max was not reached at the end of the last phase, the test continued to the next higher workload. The mean HR during the last 3 minutes in the final phase was recorded as the HR response to the workload, and the VO_2 max in l x min^{-1} was estimated by means of the Åstrand nomogram.[7]

Balance was tested with the participant standing on the preferred leg with the foot of the other leg in contact with the calf of the supporting leg. The participant slowly turned the head from side-to-side. The time in seconds maintaining the position without losing balance was recorded.[16] Inter-rater reliability was .90.[16]

Maximal isometric lifting strength (Kp) was assessed by the knee height upright pull as described in an earlier study.[17] The force is assessed with the participant standing on a plate with a strain gauge dynamometer attached to a handle and the maximum force in a vertical direction is measured as the individual maintains a neutral lumbar spine. Patients completed 2 trials and the highest result was recorded. Inter-rater reliability was .94 for men and .88 for women.[16]

Endurance of the back muscles was estimated using the isometric back endurance test.[18] Measures were taken with the participant in a prone position with the trunk positioned horizontal outside of a bench. The participant was instructed to keep this position for as long as possible, and the number of seconds was recorded. Inter-rater reliability was .80.[16]

Dynamic endurance in abdominal muscles was measured in the supine position with hips and knees flexed 90° and supported.[16] The participant was to curl up above a mark on the test mat with hands on the opposite shoulders, and the number of curl-ups above the mark at a rate of 25 per minute was recorded. Inter-rater reliability was .95 for men and .93 for women.[16]

Dynamic endurance in arm muscles was measured in the supine position. The participant was to lift a barbell by arm extension (12 kg for women, 20 kg for men).[16] The number of lifts to straight arms at a rate of 25 per minute was recorded. Inter-rater reliability was .92.[16]

Psychological Measures at Arbitrary Times throughout the Exercise Period

The Physical Self Description Questionnaire (PSDQ-S). We used the short (47 items) version of the PSDQ-S.[19] This instrument measures 11 dimensions related to the individual's self-perception: Strength (4 items), Body fat (4 items), Physical activity (4 items), Endurance (4 items), Sport competence, (4 items), Coordination (5 items), Health (5 items), Appearance, (4 items), Flexibility, (4 items), General physical self-concept, (4 items), and Self-esteem (5 items). For each of the 11 dimensions a mean score was calculated along a continuous scale varying from 1.0 to 6.0, with a low value representing negative and a high value representing positive self-perception.

Flow during exercise. The participants' experience of psychological flow[20] during the sessions was investigated once during the 6th week of the exercise period (KoRT_D) using a modified version of the Swedish Flow Proneness Questionnaire (SFPQ).[21] For this study, the SFPQ was adapted to flow during training sessions and we asked the following question: "When you participate in the exercise sessions, how often does it happen that...." The SFPQ has 7 items: (1) ...you feel bored? (2) ...it feels as if your ability to perform what you do completely matches how difficult it is? (3)...you have a clear picture of what you want to achieve, and what you need to do to get there? (4)... you are conscious of how well or poorly you perform what you are doing? (5)... you feel completely concentrated? (6) ... you have a sense of complete control? (7) ...what you do feels extremely enjoyable to do? Each item has 5 response alternatives: Never (coded 0), Rarely (1), Sometimes (2); Often (3); Every day, or almost every day (4). The scores for the first question (...you feel bored?) were reversed, and the mean of the scores for all 7 items was then calculated. Higher values represented more flow experience.

Experience of the exercise sessions and opinions about the instructors. There exists no established instrument for measuring participants' experience during training sessions or their opinions of the instructors. Therefore, we devised such instruments to answer some of the questions posed in the study.

The participants' experience during the exercise sessions was measured once during the exercise period (KoRT_C). Approximate translations from Swedish are "I enjoy exercising with my group," "I feel bored," "I think it is very pleasant," "After I have been exercising, I have a good feeling in my body," "I think it is embarrassing to participate in the training," "The sound is well-suited to the choice of exercises," "The instructors motivate me to push myself," "I don't like it," "I think it's fun," "The instructor's movements are in synchrony with the sound," "I move in synchrony with the sound," and "The instructor gives me confidence." Participants responded by indicating a position with a pencil on a visual analog scale anchored by "strongly disagree" and "strongly agree." Scores for items with a negative statement were reversed before computing the mean across items, with a higher mean reflecting higher liking and positive experience. The reliability of the scale as measured by Cronbach's alpha was .84.

The participants' opinions of the instructors and the exercises were measured once during the 6th and 7th week of the exercise period (KoRT_D). The questionnaire included 4 statements about the instructors (in translation from Swedish): "NN pushes me to exert myself too much from what I can" (Manage), "NN pushes me to exert myself too much to ensure a minimization of the risk of

injury" (Pain), "NN pushes me too little to ensure a maximization of fitness improvement" (Fitness), "NN pushes me too little for me to feel energized" (Energy), and 2 questions about the exercises: "The exercises during the aerobic fitness part are too complicated for me" and "The exercises during the strength conditioning part are too complicated for me." Because the 4 questions were asked for each instructor and there were 4 instructors, a total of 16 items measured participants' experiences with the instructors. Participants responded by indicating a position with a pencil on a visual analog scale anchored by "strongly disagree" and "strongly agree." The mean across items was calculated, with lower scores reflecting positive experiences.

Experience of the music. The participants' experience and liking of the music was measured twice during the exercise period by means of a custom-built computerized instrument. Each participant received training on the procedure under the supervision of an experimenter using 3 music clips not featured in the exercise, which took from 1 to 5 minutes. Participants listened to 10-second excerpts from each of the 14 auditory stimuli used in their exercise routine, one-at-a-time in random order. For each excerpt, they rated how much they agreed with each of 5 scales; "I like it," "Movement inducing," "Complex," "Repetitive," and "Fast." In addition, the first rating session also included the scales "Difficult," "Driving," "Interesting," and "Motivating," but these were eliminated from the second session to reduce the rating time. The scales were represented by a horizontal line with 11 points marked with the numbers 0 through 10, anchored by "Not at all" at the zero end of the scale and "Completely" at the 10 end. The 14 music excerpts were played one-by-one through headphones connected to the computer. After each excerpt, the participant was required to move a slider beneath a visual analog scale on the computer screen to the desired position between the anchors. The ratings are similar to the Brunel Music Rating Inventroy-2 (BMRI) of Karageorghis et al[22] but because it did not meet our needs fully, we used a self-constructed questionnaire focusing more on measuring the appreciation of music rather than the BMRI's emphasis on motivation. This self-constructed questionnaire has previous demonstrated validity.[23,24]

Measures Obtained during and after Each Exercise Session

Heart rate (HR). HR was continuously recorded during every session for each participant using the Activio Fitness Lite system from Activio Co. (Activio AB, Stockholm, Sweden). The system consists of pulse belts worn around the participant's chest that transmits HR signals to a radio receiver connected by a USB device to a computer running the Activio Sport System software (version 3.1.0.3). The software records the signal of each belt in real-time at a sampling rate of 1 Hz. The mean HR of each participant was calculated for aerobic exercises (song 4, 5, 8, 9, 12 and 13), and for the body conditioning part ("strength"; song block 6, 7, 10, 11). In a next step we calculated the participants' relative exercise intensity level using the equation of mean HR/(208-0.7 x age).

After each session participants were required to complete Borg's RPE-scale in 3 versions; the normal, current RPE, the participant's estimate of maximal RPE during the exercise session, and the participant's estimate of average RPE during the exercise session (KoRT_B).

Instruments Administered Post-exercise

Changes in psychological fitness and well-being. The extent to which the training also affected participants' mental health was assessed with 12 items of states deemed relevant for general psychological well-being (KoRT_F) by the end of the training period: (1) I am relaxed, (2) I can deal with unexpected events, (3) I am worried, (4) I sleep well, (5) I can handle stress and demands, (6) I feel well physically, (7) I am comfortable with myself, (8) I am often irritable, (9) I can cope with a lot, (10) I am happy, (11) I am hardworking and don't easily give up, and (12) I find it easy to concentrate. Each item had 7 response alternatives ordered on a bi-directional scale: "Large negative change" (coded -3), "Moderate negative change" (-2), "Small negative change" (-1); "No change" (0); "Small positive change" (1), "moderate positive change" (2) and "large positive change" (3).

Changes in attitude to physical activities. Participants' attitudes towards physical activity by the end of the training period were assessed with 10 statements (KoRT_H): Participating in the music exercise sessions has… (1) …taught me a lot about my own body and how it works (body awareness), (2) …taught me how much training I can do (enjoyable amount of training), (3) …taught me that I can accomplish more physical activity than I previously thought, (4) …positively influenced my attitude toward physical activity, (5) …encouraged me to continue to be physically active, (6) …encouraged me to embrace a healthier lifestyle (life style change), (7) …led to me to discover new sides about my self, (8) …given me better self confidence, (9) …encouraged me to continue with individual training, and (10) …encouraged me to continue with group training. For each statement, the participants rated their level of agreement on a 10 cm scale represented by a horizontal line with the ends anchored by "strongly disagree" at the zero end of the scale to "strongly agree" at the opposite end. The survey also included 2 open questions: "I will continue to be physically active because…." and "'Prerequisites for me to continue being physically active are…."

Changes in physical problems. Musculoskeletal pain or discomfort in the neck, upper and lower back, or hip and knees during the exercise period also was assessed post-exercise. These questions

Table 1
Descriptive Statistics of the Participants

	Women, N = 92	Men, N = 16
Age (years)[a]	44 (12)	52 (11)
Height (cm)[a]	166 (6)	179 (7)
Weight (kg)[a]	68 (12)	87 (8)
Questionnaire Data		
FABQ_PA (Score: 0-30)[b]	7 (0-24)	5 (0-20)
SES (Score: 0-200)[a]	187 (16)	184 (26)
SF-36 (Score: 0-100%)		
Physical functioning (PF)[a]	92.0 (9.4)	88.8 (15.0)
Role-physical (RP)[a]	87.0 (25.5)	87.5 (27.2)
Bodily pain (BP)[a]	74.5 (19.8)	81.8 (23.0)
General health (GH)[a]	71.7 (16.8)	71.4 (23.6)
Vitality (V)[a]	54.5 (25.1)	59.7 (24.1)
Social functioning (SF)[a]	86.6 (17.2)	89.1 (25.2)
Role-emotional (RE)[a]	72.9 (35.6)	75.0 (39.4)
Mental health (MH)[a]	73.9 (16.2)	78.0 (22.0)
Physical component score[a]	52.3 (7.1)	51.6 (7.8)
Mental component score[a]	43.7 (12.5)	46 (10.9)
PSDQ-S (Scale: 1-6)		
Action[a]	2.78 (0.88)	3.1 (1.21)
Appearance[a]	3.66 (1.16)	3.8 (0.73)
Bodyfat[a]	3.15 (1.62)	2.3 (1.15)
Coordination[a]	4.10 (1.22)	3.5 (1.32)
Endurance[a]	2.95 (1.11)	3.1 (0.82)
Flexibility[a]	3.97 (1.28)	3.5 (1.14)
Health[a]	5.42 (0.91)	5.3 (1.16)
Sport[a]	2.99 (1.31)	3.4 (1.25)
Strength[a]	3.33 (1.13)	3.6 (0.87)
Global physical[a]	3.45 (1.22)	3.5 (1.45)
Global esteem[a]	4.60 (0.82)	4.40 (0.74)
Flow during training (Scale: 0-4)[a]	2.72 (0.5)	2.71 (0.5)
Experience of the exercise sessions (Scale: 0-10)[a]	6.8 (1.5)	6.7 (1.6)
Participation (0-100%)[a]	61 (20)	64 (23)
Training Intensity (0-100%)		
Aerobic exercises[a]	84 (7)	82 (6)
Strength exercises[a]	74 (8)	71 (6)
Perceived Effort (Scale: 6-20)		
Current RPE [b]	12 (7-16)	12 (8-16)
Maximal RPE [b]	16 (12-20)	16 (13-20)
Average RPE [b]	14 (12-17)	14 (12-17)

Note.
a = Mean (SD)
b = Median (Min-Max)

Table 2
Pre- and Post-test Values of Blood Pressure, Physical Performance Tests and SF-36

	Music Exercise Group				Comparison Group			
	Women (N = 92)		Men (N = 16)		Women (N = 25)		Men (N = 25)	
	Before	After	Before	After	Before	After	Before	After
Syst. BP (mmHg)[a,c]	124 (15)	117 (16)	149 (20)	131 (19)	125 (17)	126 (18)	140 (15)	141 (18)
Diast. BP (mmHg)[a,d]	75 (9)	72 (10)	87 (11)	81 (11)	74 (10)	74 (8)	83 (13)	85 (12)
VO_2 max (l/min)[a,d]	2.3 (0.5)	2.5 (0.5)	2.9 (0.9)	2.9 (0.8)	2.2 (0.5)	2.2 (0.5)	2.9 (0.6)	3.0 (0.6)
VO_2 max (ml/kg x min)[a]	35.4 (9)	38.7 (9)	36.9 (16)	37.6 (15)	32.8 (9)	32.6 (9)	35.6 (16)	38.0 (15)
Two hand lift (kp)[a]	80 (18)	82 (16)	138 (27)	132 (24)	80 (17)	81 (11)	131 (20)	129 (17)
Handgrip (kg)[a]	77 (11)	81 (10)	114 (12)	116 (15)	77 (11)	80 (8)	113 (13)	117 (13)
Back endurance (s)[a]	100 (56)	103 (51)	100 (42)	97 (63)	85 (57)	84 (47)	101 (42)	105 (52)
Bench-press (number)[a]	21 (11)	24 (12)	38 (9)	36 (15)	19 (11)	21 (9)	35 (11	34 (14)
Curl-ups (number)[a]	13 (14)	16 (16)	23 (11)	27 (10)	12 (14)	12 (17)	17 (9)	17 (8)
Flexibility (1-11)[b,c]	9 (1-11)	10 (5-11)	8 (3-10)	10 (6-11)	9 (3-10)	9 (3-11)	8 (2-10)	8 (3-11)
Balance (s)[a]	43 (40)	64 (46)	39 (35)	37 (41)	50 (38)	58 (44)	34 (31)	37 (31)
SF-36								
Physical functioning (PF)[a,e]	92 (9)	93 (9)	88 (15)	93 (7)	-	-	-	-
Role-physical (RP)[a,e]	87 (26)	88 (26)	88 (27)	92 (19)	-	-	-	-
Bodily pain (BP)[a,e]	75 (20)	77 (20)	82 (23)	77 (19)	-	-	-	-
General health (GH)[a,f]	72 (17)	77 (16)	71 (24)	85 (20)	-	-	-	-
Vitality (V)[a,e]	55 (25)	63 (19)	60 (24)	67 (28)	-	-	-	-
Social functioning (SF)[a,e]	87 (17)	91 (17)	89 (25)	90 (17)	-	-	-	-
Role-emotional (RE)[a]	73 (36)	83 (30)	75 (39)	87 (29)	-	-	-	-
Mental health (MH)[a]	74 (16)	79 (15)	78 (22)	85 (18)	-	-	-	-

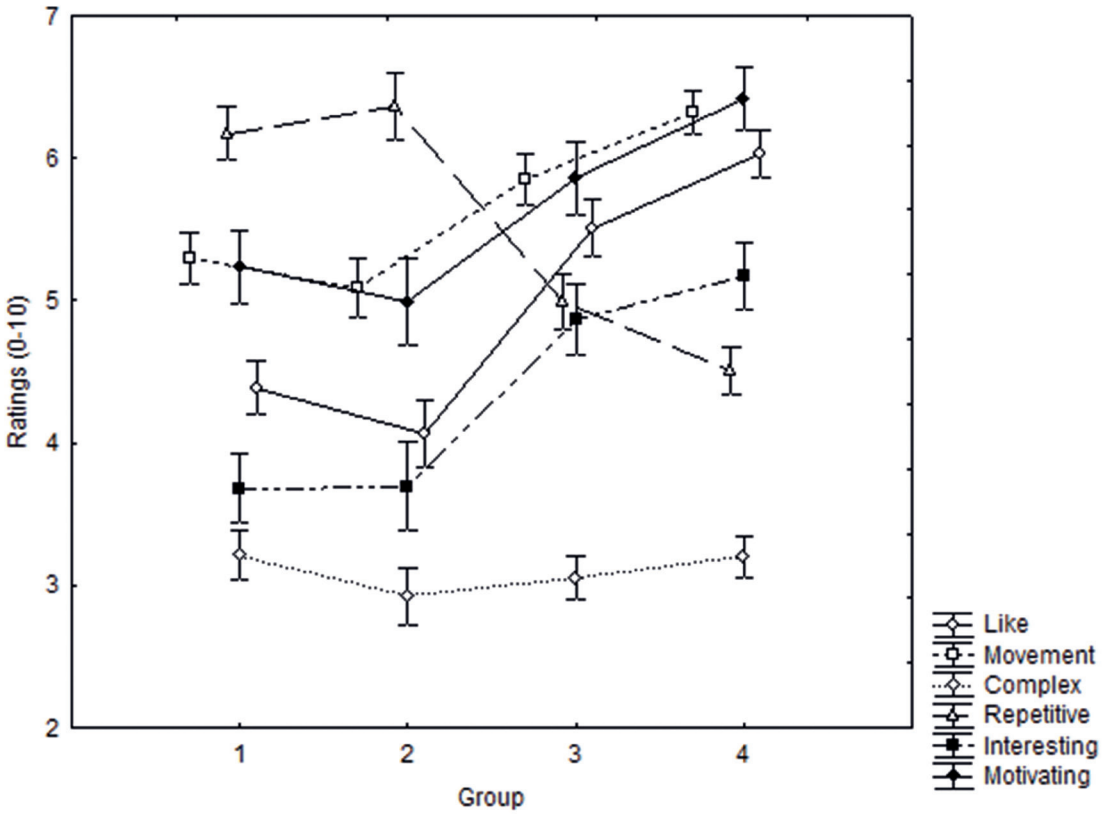
Note.
a = Mean (SD), b = Median (Min-Max), c = Linear regression analysis with post-test value as the dependent variable and pre-test value and group (1/0) as independent values, showed a significant difference between the Music exercise and the Control group in this particular test for both men and women (men; Post-test systolic blood pressure = 17.332 + 0.882 * Pre-test value – 15.240 * Group, R^2 = 0.91, p < .001, Post-test flexibility = 1.296 + 0.837 * Pre-test value + 1.257 * Group, R^2 = 0.82, p < .001, women; Post-test systolic blood pressure = 23.729 + 0.802 * Pre-test value – 5.858 * Group, R^2 = 0.55, p < .001, Post-test flexibility = 2.579 + 0.682 * Pre-test value + 0.995 * Group, R^2 = 0.74, p < .001). d = Linear regression analysis with post-test value as the dependent variable and pre-test and group (1/0) as independent values, showed a significant difference between the Music exercise and Control group in this particular test for the women (Post-test diastolic blood pressure = 9.155 + 0.880 * Pre-test value – 2.565 * Group, R^2 = 0.63, p < .001, Post-test VO_2 max = 0.805 + 0.674 * Pre-test value + 0.171 * Group, R^2 = 0.52, p < .001, e = Paired samples t-test showed a significant difference between pre- and post- ratings in this SF-36 domain for women (V, t = -3.046, df = 87, p = .003, SF, t = -2.209, df = 87, p = .30, RE, t = -2.299, df = 87, p = .024, MH, t = -2.451, df = 87, p = .007). f = Paired samples t-test showed a significant difference between pre- and post- ratings in this SF-36 domain for both men and women (men; GH, t = -2.530, df = 15, p = .023, women; GH, t = -2.750, df = 87, p = .007)

were formulated retrospectively. The response alternatives were "No" (coded 0), "Yes" (coded 1) or "I have no complaints at the moment, but I have had considerable discomfort during the last 3 months" (coded 3).

Analyses

Included in the analyses were women and men who had participated in one or more music-exercise sessions and performed both pre-tests and post-tests. Descriptive statistics are provided in terms of means (M) and standard deviations (SD)

Figure 2
Group Ratings of the Music[a]



Note.
a = The ratings were measured across music examples as a function of groups. The scales were anchored by "Not at all" at the zero end of the scale and "Completely" at the 10 end. ANOVA showed that there were differences between groups in "I like it" ($F=73.5$, $df = 2949$, $p < .001$) , "Movement inducing" ($F=35.9$, $df = 2949$, $p < .001$), "Repetitive" ($F=78.7$, $df = 2949$, $p < .001$), "Interesting" ($F=32.9$, $df = 1592$, $p < .001$) , and "Motivating" ($F=24.6$, $df = 1592$, $p < .001$).

for continuous and normally distributed variables, and by median and minimum-maximum for ordinal and/or non-normally distributed data. Independent-samples t-tests or Mann-Whitney U-tests were used to investigate whether there were differences between men and women. A series of one-way analysis of variance (ANOVA) tests were performed to investigate whether participants in Group 1-4 thought differently about the music that was played during their exercise sessions and whether there were differences in exercise intensity or effect of exercise. ANOVA was also performed to investigate whether the participants thought differently about the instructors.

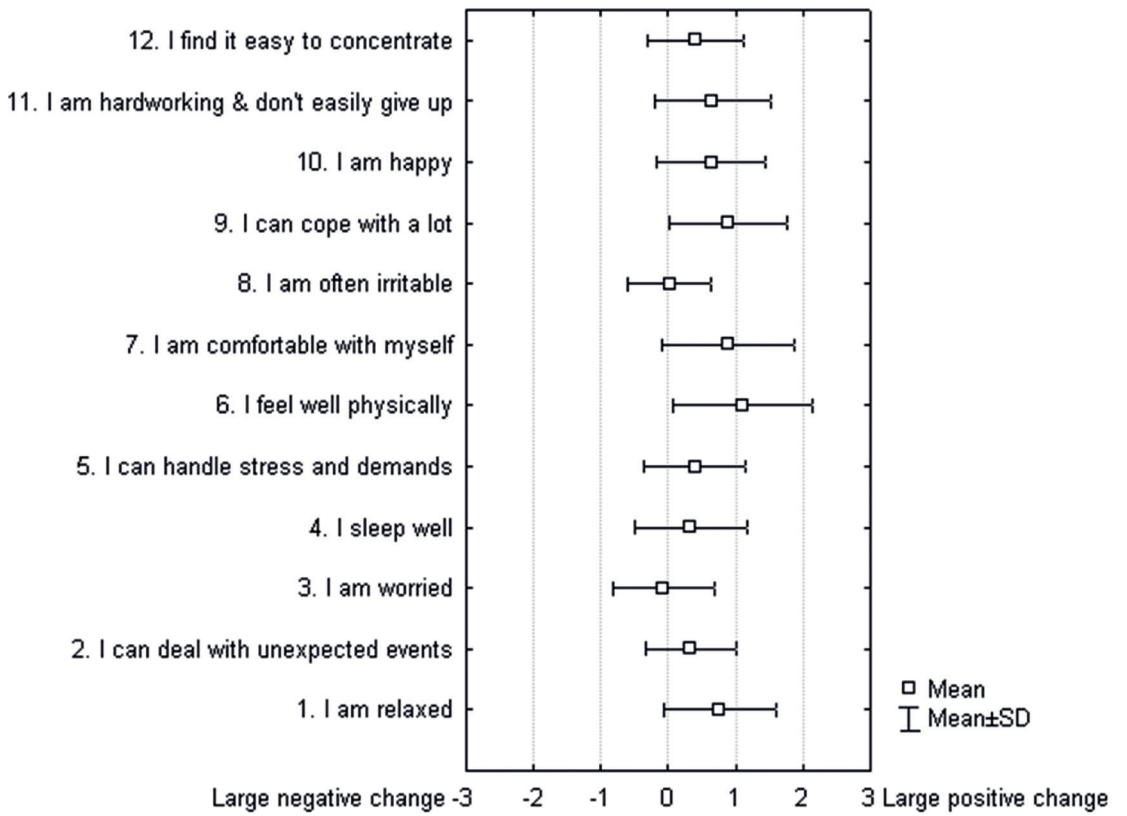
To investigate the effects of the 11 weeks of twice-weekly training sessions on outcomes, univariate linear regression analyses were performed in which the post-test performance was the dependent variable, and the pre-test performance and group (music-exercise and comparison group, 0/1) were the independent variables. To investigate the effects of training on SF-36 domains, paired t-tests were used because the comparison group had not answered the SF-36. The criterion for statistical significance was set at .05.

RESULTS

No adverse events were identified. No significant differences regarding descriptive statistics or physical performance were found among groups 1-4 or between the music-exercise and comparison groups.

Of the 146 participants, 92 women and 16 men were included in the analyses (Group 1, N = 26,

Figure 3
Mean Ratings of the Participants' Perception of Their Change in Mental State by End of Training Period[a]



Note.
a = All ratings except Worried (3) and Irritable (8) were statistically different from zero, according to .995 confidence intervals. Only participants who had exercised more than one time were included in the analysis (N = 99).

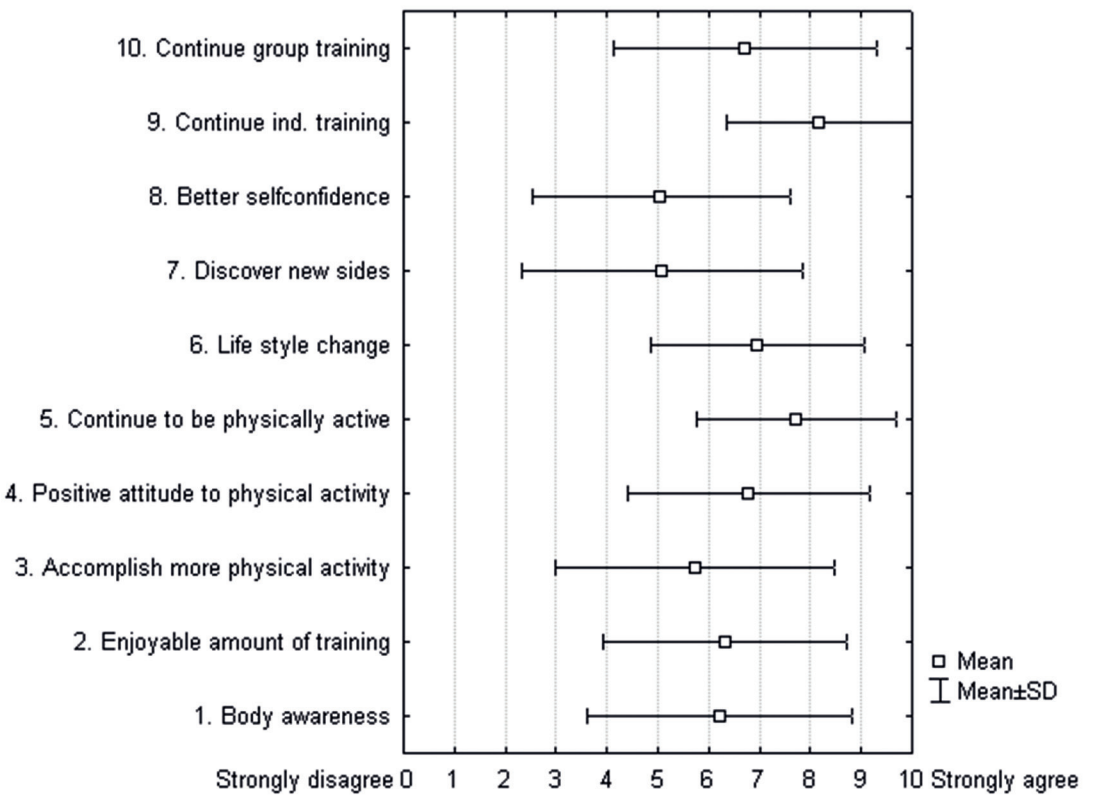
Group 2, N = 28, Group 3, N = 25 and Group 4, N = 29). The reasons for not participating were lack of time. The descriptive statistics of the participants, questionnaire data, training intensity, and ratings of perceived exertion are presented in Table 1. The exercise intensity that the participants selected during Aerobic I and Aerobic II varied between 61% and 100% of their estimated maximal heart rate. No significant differences in participation, RPE, or training intensity were found between men and women.

Pre-test and post-test values of blood pressure, physical performance tests, and the SF-36 for men and women in the music-exercise and comparison groups are shown in Table 2. Participants decreased their systolic blood pressure by 7 and 18 mean mm Hg for women and men, respectively. Flexibility increased among music-exercise participants; no general increase of muscular strength and endurance was evident, but cardiovascular capacity increased to a significant degree among women. Among men, the paired t-tests showed significant differences over time in the general health perceptions domain; among women, significant differences were found for the general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health domains.

We found no significant differences in pre-test questionnaire data, participation, effects of participation, RPE or exercise intensity among the 4 exercise groups.

Regarding opinions about the instructors, the results of the ANOVA showed that for 3 of the 4 questions there was a significant mean difference (SD in parentheses) in the way the instructors pushed

Figure 4
Mean Ratings of Participants' Attitudes Towards Physical Activity by End of the Training Period



Note.
a = All ratings except Positive attitude to physical activity (4), Discover new sides (7), and Better self-confidence (8) were significantly higher than the scale midpoint (5), according to .99 confidence intervals (CI), while (3) was significantly higher according to .95 CI

the participants (Manage, 1.2 (1.70) - 2.4 (2.70), $F(3, 359) = 4.25$; $p < .01$; Fitness, 1.2 (1.75) - 4.2 (3.30), $F(3,360) = 23.80$, $p < .0001$; Energy, 1.1 (1.70) - 4.2 (3.30) $F(3,361) = 21.64$, $p < .0001$). Degrees of freedom for the error terms vary due to occasional missing data because some participants neglected to rate each item. Regarding opinions about the exercises during the aerobic fitness and strength conditioning parts, the mean values were 1.48 (2.33) and 1.10 (1.45), respectively.

The 4 groups rated what they thought of the music played during the exercise sessions (Figure 2). The ratings were measured across music examples as a function of groups on a 0-10 scale, with zero meaning "not at all" and "completely" represented by a 10. ANOVA showed that there were differences among groups in "I like it" ($F(2949) = 73.5$, $p < .001$) , "Movement inducing" ($F(2949) = 35.9$, $p < .001$), "Repetitive" ($F(2949) = 78.7$, $p < .001$), "Interesting" ($F(1592) = 32.9$, $p < .001$), and "Motivating" ($F(1592) = 24.6$, $p < .001$).

By the end of the training period, all participants reported a positive change in how well they felt physically and how much they could cope (Figure 3). Most participants also reported a positive change in perception of feeling relaxed, comfortable, and happy.

The participants' attitudes about physical activity and their body are shown in Figure 4. The questions were framed "...as a result of participating in the training," for the purpose of trying to reflect a relationship between how they actually perceived the training and their subsequent willingness to lead a more physically active life, embrace a healthier lifestyle, and to continue with training.

Twenty of the participants reported that they had experienced musculoskeletal discomfort in one or more body areas during the exercise period.

The most common complaint was discomfort in the knee joint, followed by low back pain. None of the participants had to stop training due to their complaints.

DISCUSSION

Overall, there was a noticeable effect of music-exercise in several of the tests versus the comparison group. First, participants in the music-exercise group lowered their systolic blood pressure. Physical activity may decrease blood pressure directly or indirectly by affecting other risk factors or by physiological mechanisms.[25,26] Notably, the effects of music-exercise on blood pressure are on a par or higher than in earlier studies.[26] Music-exercise can, therefore, be recommended for individuals with a sedentary lifestyle at risk for hypertension.

Second, all participants who attended the exercise sessions gained flexibility, and cardiovascular capacity increased for the women. Women exhibited a mean 8% increase of VO_2 max. However, those with low initial levels of aerobic fitness (≤ 2.4 l/m) exhibited up to 38% improvement. In contrast, only modest or no improvements were found for individuals with higher initial levels of aerobic fitness, supporting previous findings that exercise is especially effective for those who have a low fitness level.[7] The effect on flexibility can be explained by the fact that we encouraged the participants to perform all movements to the maximum of their capabilities. The frequency of the practice was at least 8 repetitions per exercise and in accordance with recommendations this dosage was appropriate to promote flexibility.[5,8]

In contrast to the apparent increase in flexibility, muscular strength and endurance did generally not increase across the exercise period. This finding indicates that either the specific workload, number of exercises, or duration was too small to suit the unique needs of the participants. It appears most likely that the workload was too low, because many of the exercises targeted the same muscle groups and every exercise was repeated 16 to 24 times, which is well within recommendations.[5,8] Therefore, if the goal of a recommended or prescribed activity is to increase the maximal strength, it appears useful to measure each participant's strength prior to training so that the workload can be set individually. Another option might be to prescribe specific exercises targeting strength in addition to the music-exercise.

Third, although some of the participants did not increase their physical test performance, they reported that they experienced a positive change in how well they felt physically. Most participants also felt more relaxed, comfortable, and happy after the music-exercise period. This was supported by the positive SF-36 change. Physical activity in itself has many health benefits, including positive effects on mental states[27] and a reduced risk of cardiovascular disease.[28] There is, however, also a great deal of literature regarding the effects of music on stress reduction for both physical (eg, blood pressure) and psychological domains.[29] Music combined with movement is also considered as music therapy when implemented by a trained music therapist.[29] Based on earlier studies, the results described above, and the fact that the participants tended to experience flow during the music-exercise sessions, we suggest music-exercise as a way for sedentary individuals to increase their activity level, wellbeing, and quality of life.

Fourth, participants strongly agreed that their participation in exercise to music had taught them about the ability of their bodies and had increased their body awareness, a factor that may be important for long-term health.[30] Body awareness is considered essential to improve bodily function in general and to relieve pain and tension.[31] Participants also indicated that their participation had encouraged them to embrace a healthier lifestyle and reported an intention to remain physically active at the end of the 11-week exercise period. Dishman et al[32(p. 162)] noted that "feelings of enjoyment and well-being seem to be stronger motives for continued participation [than] knowledge of and belief in the health benefits of physical activity." Music-exercise might attract many people because it offers a varied workout, requires little equipment, and facilitates a sense of belonging and friendship among participants.[33] Indeed, one theory about the evolutionary value of music holds that it facilitates group bonding, which has afforded adaptive advantages on the level of group selection.[34] Regardless of the possible evolutionary explanation, it has been demonstrated that engaging in musical activities as well as simply listening to music incurs a range of psychological and physiological effects, including resistance to pain, heightened mood, and improved performance in sports.[35-37] Previous studies have not explicitly investigated the motivational powers, but Capuano et al[38] found that listening to music while exercising improved participants' weight loss. They followed a group of overweight women who dieted, exercised, and met in weekly group sessions promoting lifestyle change. The subgroup that also listened to music while they exercised exhibited greater weight loss and consistency with their exercise than those who did not listen to music. We argue, therefore, that music in combination with exercise might have made the experience from exercising positive, which in turn, might be of potential motivational significance.[39]

The self-selected intensity during the aerobic exercises was within the range recommended by the ACSM,[5] consistent with a review of intensities selected when people are "left to their own devices."[40] Ratings also indicated that participants felt that the exercises were relatively easy to perform and that the instructors did not push them too much from what they were able to perform.

In this study we tested whether different amounts of musical information had any effect on physical

performance. Whereas participants may believe that musical content is vital for their performance, and we did see significant differences in liking between groups concerning the songs, we found no significant differences among the 4 exercise groups regarding exercise intensity, RPE-ratings, or flow. In this type of exercise, setting factors like the social dynamics within the group, individual feelings toward the instructors, and the varied types of movements may have had a larger impact on improved physical performance than musical content alone. Another contributing factor to why we did not find any differences among groups we believe is because all 4 exercise groups exercised to synchronous music with the same tempo and that all versions of the songs had clearly audible beats.

Methodological Considerations

Strengths of this study include the objective measure of exercise intensity and physical capacity and the controlled experimental design. The comparison group might not have been strictly probabilistically equivalent to the music-exercise group, but this was considered acceptable given that the purpose of the comparison group was to ensure that the study group was not atypical in terms of pre-test values and variability. With respect to physical activity, general health, and cardiovascular fitness level adjusted for age, there were no differences between the music-exercise and comparison groups at pre-test. Moreover, the comparison group's test performance and activity level did not change.

An exercise program should be enjoyable[32] to contribute to well-being and to stimulate a more physically active lifestyle. The instructors were in perfect agreement that their goal was to convey enthusiasm and commitment.[41] Another ambition held in common was to make participants feel comfortable and enjoy the exercise sessions, because it has been argued that these are the most important elements for taking part in a fitness program.[39] We noticed, however, from the ratings that participants still felt that some instructors urged them to work too hard. Since we know this was not conveyed orally, it was probably the instructors' body language that was different. This point needs to be researched further.

Conclusion

The self-selected intensity during the aerobic exercise parts of the music-exercise program was well within the recommended range. The music-exercise yielded a relatively rapid decrease in blood pressure and increase in cardiovascular capacity, both important predictors of future health. Moreover, there was evidence indicating that music provides motivation to engage in effortful exercise. The amount of music information had no significant effects on physiological benefits on participants. This means that a simple and distinct rhythm may be as effective as more complex styles of music as a motivator for physical effort. The importance of musical information when exercising to asynchronous music still remains unanswered.

Human Subjects Statement

All participants gave written informed consent before commencing the study, which was approved by the University of Umeå Human Research Ethics Committee (09-196M).

Conflict of Interest Statement

This research was supported by 2 grants from the Swedish National Centre for Research in Sports (Centrum för Idrottsforskning). The authors declare that they have no competing interests.

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