Client Report

For Rock My World, Inc.

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Executive Summary

The purpose of this project was to compare the influence of music "mix" on performance, intrinsic motivation, and mood state in recreational runners. Prior to field work, all musical selections were prescreened to ensure their motivational appeal using the BMRI-2. In the field, recreational runners (n=14) were measured running an identical course with a) no music, b) traditional full-song format playlists, c) professionally mixed playlists with static beats per minute (bpm) optimized for running performance, and d) professionally mixed playlists with dynamically adjusting bpm based upon changes in acceleration. Testing was conducted July 14 through October 16 at the Exercise and Physical Activity Resource Center (EPARC) at UCSD (for music prescreening) and at Fiesta Island (for field testing.) Mean ambient conditions of morning and afternoon sessions were as follows:

Morning (n=10 participants): 21.1 (±2.7) ^{o}C, 0.63 (±0.73) mi/hr wind speed, 56.5% (±8.2%) rH.
Afternoon (n=4 participants): 27.4 (±1.3) ^{o}C , 2.10 (±0.71) mi/hr wind speed, 42% (±6.4%) rH

Measures

Participants

Participants were recruited through fliers distributed across the campuses of the University of California San Diego (UCSD) and San Diego State University (SDSU) and on bulletin boards near to Fiesta Island. Informational email was also distributed via listserv to UCSD and SDSU staff, faculty, and students. Potential participants were screened for inclusion/exclusion via telephone using the following criteria: a) between 20 and 40 years of age; b) had a running pace between 8:00-12:00 min/mile (5.0 and 7.5 mph); c) ran 2-3 times/week for the past 3 months; and d) had no positive responses to the Physical Activity Readiness Questionnaire (PAR-Q). Baseline physical measurements are included in Table 1 below.

Table 1: Participant Biometrics

	Units	Mean	Std. Deviation	Minimum	Maximum
Age	Yrs	24.786	2.9136	21.0	30.0
Ht	m	1.6687	.07127	1.52	1.75
Wt	Kg	66.1753	11.63174	54.09	95.36
BMI	kg/m2	23.7287	3.59124	19.80	32.59

Physical Measurements

Heart rate was assessed using a Zephyr heart monitor (Zephyr Technology Corp, Annapolis, MD), that provided a time-stamped record of heart and breathing rates, and a TomTom Sports Watch (TomTom International, Amsterdam, Netherlands) which provided a time-stamped record of heart rate, speed, and distance.

Survey Measurements

Music

Brunel Music Rating Inventory-2 (BMRI-2)

The BMRI-2 is a music rating system that asks participants to rate six elements of music on a seven-point Likert scale from "strongly disagree" (1) to "strongly agree" (7). The six elements of music measured were: rhythm, style, melody, tempo, instruments, and beat. Participants were asked to rate each element based on how motivational it

would be to them while running. Individual scores were summed, and scores were averaged within cohorts (5 participants/cohort). In order to be considered motivational, and included, songs had to have a mean score of 33 (average between somewhat agree (5) and agree (6)).

Psychological

Intrinsic Motivation Inventory (IMI)

Intrinsic motivation was assessed by administering the Short Form Intrinsic Motivation Inventory (IMI). The IMI consisted of 22 questions whose subscales include: Interest/Enjoyment, Perceived Competence, Pressure/Tension, and Perceived Choice. Items were rated on a seven-point Likert scale that ranged from "strongly disagree" (1) to "strongly agree" (7). The interest/enjoyment subscale is considered to be a direct self-report of intrinsic motivation (IM) while perceived confidence and perceived choice are predictors of behavior and emotional states resulting from improved IM. Conversely, pressure/tension is a negative predictor of IM, with higher values indicating that respondents feel forced to engage in the activity. Responses were reverse coded (where appropriate) so that high(er) scores are indicative of greater motivation.

Flow State Scale-2 (FSS-2)

Flow is defined as an ideal state in which an individual finds an activity deeply enjoyable, and is highly correlated with intrinsic motivation. The FSS-2 is a 36-item questionnaire, measuring the nine dimensions of flow including Challenge-Skill Balance, Action-Awareness Merging, Clear Goals, Unambiguous Feedback, Concentration on Task at Hand, Sense of Control, Loss of Self-Consciousness, Transformation of Time, and Autotelic Experience. Responses were scored on a five-point Likert scale where (1) indicated "strongly disagree" and (5) indicated "strongly agree."

Profile of Mood States (POMS)

POMS is commonly used to examine mood in physical activity research. The POMS 29-item version was used in this study. It assessed several components of mood including tension/anxiety/depression, vigor/activity, fatigue/inertia, and confusion/bewilderment. This scale was included to examine possible changes in "negative" mood states. Responses were scored on a five-point Likert scale that ranged from "not at all" (1) to "extremely" (5). POMS subscale coding was not changed, so lower scores on the "negative" mood states (and higher on the "positive") are indicative of "better" mood.

Procedures

Participants who met inclusion criteria were scheduled to listen to music at the EPARC lab. After arriving, participants provided informed consent, height and weight were measured using a stadiometer (Dectecto, Webb City, MO) and age was recorded. The BMRI-2 music rating scale and the musical components it measures were explained in lay language. After familiarization, participants were asked to listen to 40 songs presented in a randomized order. Participants were instructed to listen to each song for as long as needed to rate the song and were asked to listen to multiple time-points within each song. Cohorts two and three were asked to repeat this procedure with 40 additional songs because the first 40 did not yield enough music surpassing the motivational threshold (BMRI ≥33) to make a complete playlist.

Field trials were organized using the following criteria: 1. All trials were scheduled at the same time of day (i.e. morning or afternoon); 2. All trials were completed within three weeks of the first trial, and 3. There was a minimum of 48 hours between trials. Participants completed the following trials in a randomized order: 1. No music, 2. Regular, full-length format playlist, 3. Professionally mixed playlist with static beats per minute (bpm) and 4. Professionally mixed playlist with dynamic bpm adaptation responsive to changes in accelerometery.

The four trials took place at Fiesta Island in San Diego, CA. Temperature, wind speed (Vktech, Shen Zhen, China), and humidity (Springfield Precision, Oak Brook, Illinois) were recorded before each trial began. The participant actively warmed up prior to the exercise with a walk or jog of approximately 0.25 mi. The participant was fitted with the two heart rate monitors. The devices were deployed in a way that participants remained naïve to the amount of time that had passed and the distance travelled. If the trial included music, participants were given the option to carry the I-phone music player (Apple Inc, Cupertino, CA) in their hand, in an armband, or in a waistband. Device placement was then kept consistent across conditions. Participants were instructed not to skip any songs. Participants ran on the outside of the existing road in a direction opposite to vehicular traffic. Time to reach a first checkpoint (1.33 miles), and one lap (2.59 miles) were recorded. After exactly thirty minutes, participants were stopped, headphones were removed, and total distance covered was marked and recorded. Participants were instructed to actively cool down for 2 minutes (walking and/or stretching were encouraged) before being asked to sit down in a chair. The participant remained seated for at least 7 min post exercise.

Data Analysis

Descriptive statistics, including average/mean +/- standard deviations (SD) were computed for all variables of interest, and have previously been delivered to Rock My World Inc. (See Appendix A to this report). All performance and psychological variables were analyzed via repeated measures analysis of variance (RM ANOVA) using the Statistical Package for Social Sciences (SPSS) version 22.1, which is a commonly used statistics program. Although statistical tests of significance have typically been established a priori at an alpha level of $P< 0.05$, given the exploratory nature of this study, we evaluated and discussed the implications of findings that yielded a more "relaxed" p value of up to 0.20. The results are reported and discussed below.

Results

For a complete list of average/mean values and standard deviations, please refer to Appendix A. There were no significant differences in physiological measures of heart rate (HR) during exercise, HR recovery, or breathing rate (BR) across the 4 music conditions. There was also no significant difference in performance measured as speed during the 4 music trials, however, speed as calculated by total distance covered in 30 minutes approached significance. Averages, standard deviations, and confidence intervals for these performance data are shown below in Table 2.

Table 2: Speed by Music Condition (p=.122)

Music Condition	Mean Speed (m/sec)	Std. Deviation	Mean Speed (mi/hour)	95% Confidence Interval	
				Lower Bound	Upper Bound
No Music	2.972	.084	6.65	2.791	3.154
Standard Playlists	2.971	.077	6.65	2.804	3.139
Optimized Playlist	3.050	.090	6.82	2.856	3.244
Adaptive Playlist	3.021	.073	6.76	2.864	3.179

We found a significant difference on the IMI and three of its four subscales, including Interest/Enjoyment, Perceived Competence and Perceived Choice. Additionally, the IMI's Pressure/Tension subscale approached significance. POMS composite scores were not significantly different, but the vigor subscale did show a significant difference with higher scores observed in the optimized Static BPM compared to standard playlists. Near significance was also observed for the fatigue subscale of the POMS. There was no significant difference between music conditions for the FSS, whereas the Challenge/Skill Balance approached significance.

Table 3 shows the confidence intervals of the differences between specific conditions that were statistically significant. For a complete list of average/mean values and standard deviations, please refer to Appendix A.

Table 3 Conditional Differences

Scale	Condition	P value	Total Possible	CI low	CI high
IMI (Total)	3>2	.024	154	2.1	35.7
IMI (Interest/Enjoyment)	3>1, 3>2, 3>4	.032 .014 .029	49	0.5 1.03 0.2	14.2 10.8 5.5
IMI (Perceived Competence)	3>2	.035	35	0.3	9.7
IMI (Perceived Choice)	3>2	.026	35	0.5	9.5
POMS (Vigor)	3>2	.027	35	0.5	9.5

IMI=Intrinsic Motivation Inventory;
CI=Confidence Interval;
Condition 1= No music; Condition 2=Standard Playlists, Condition 3= Optomized Static BPM; Condition 4=My Beat Adaptive BPM.

Conclusions

Despite the intuitive belief that music improves running performance in terms of speed and endurance, the literature on the subject shows mixed results (for a more complete review of the literature on music as a performance-enhancing aid, please see Karageorghis and Priest, 2012 Parts I and II). Overall, the results of this project provide some evidence to suggest there may be some performance benefits to listening to music that has that has either a beat/tempo optimized for running, or an adaptive system such that tempo changes in response to external (physiological) stimuli. Data presented in Table 2 (average speed across the four conditions) shows a clear trend toward higher speeds with the optimized and/or adaptable music experiences. Additionally, it is important to note here that participants were instructed to run at a comfortable pace, not as fast as possible. Had they been instructed to give a maximum effort on each trial, we may have observed greater differences in speed (and other markers of performance) for the optimized and/or adaptable music conditions.

While performance results were inconclusive, the emotional/motivational appeal of the Rock My Run product was clear. The main evidence for this can be seen when examining the IMI, a measurement device intended to assess the subjective experience of running, and the degree to which participant's enjoyed and felt

engaged in the experience. Given that all of the positive subscales of the IMI were statistically significant, and the remaining (negative) subscale was near statistical significance it seems reasonable to conclude that music that has been mixed together to maintain an optimized beat encourages the listener to experience and internalize more positive feelings about the experience and the outcomes. Moreover, confidence in the motivational qualities of Rock My Run's musical mixes is encouraged by the results of the other psychosocial measurement tools. Specifically, participants' also scored significantly higher on the POMS subscale Vigor (a qualitative measurement of feelings of strength and stamina) and achieved nearly significant difference on the FSS subscale Challenge/Skill Balance which indicates improved feelings regarding capability compared to the challenge(s) imposed.

END