

# Learning with Background Music: A Field Experiment

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# Background

## **Inconsistent findings:** effects of background music on learning

- Role of background music from emotional and cognitive aspects
  - emotional: arousal-mood-hypothesis (Husain, 2002)
  - cognitive: irrelevant sound effect (Jones, 1999)
- Role of fine-grained music characteristic
  - genre, tempo, rhythm strength, happiness, energy

## **Ecological validity:** a naturalistic user experiment

- conduct learning sessions for one week
- a novel mobile-based music app



# Research Questions

1. What kind of music would be deemed as **enhancing** vs. **distracting** learning?
2. Would learning enhancement **co-occur** with mood enhancement?
3. Would personal **music preference** be related to **learning performance & learning engagement**?



# **Methodology**

## **A Field Experiment**

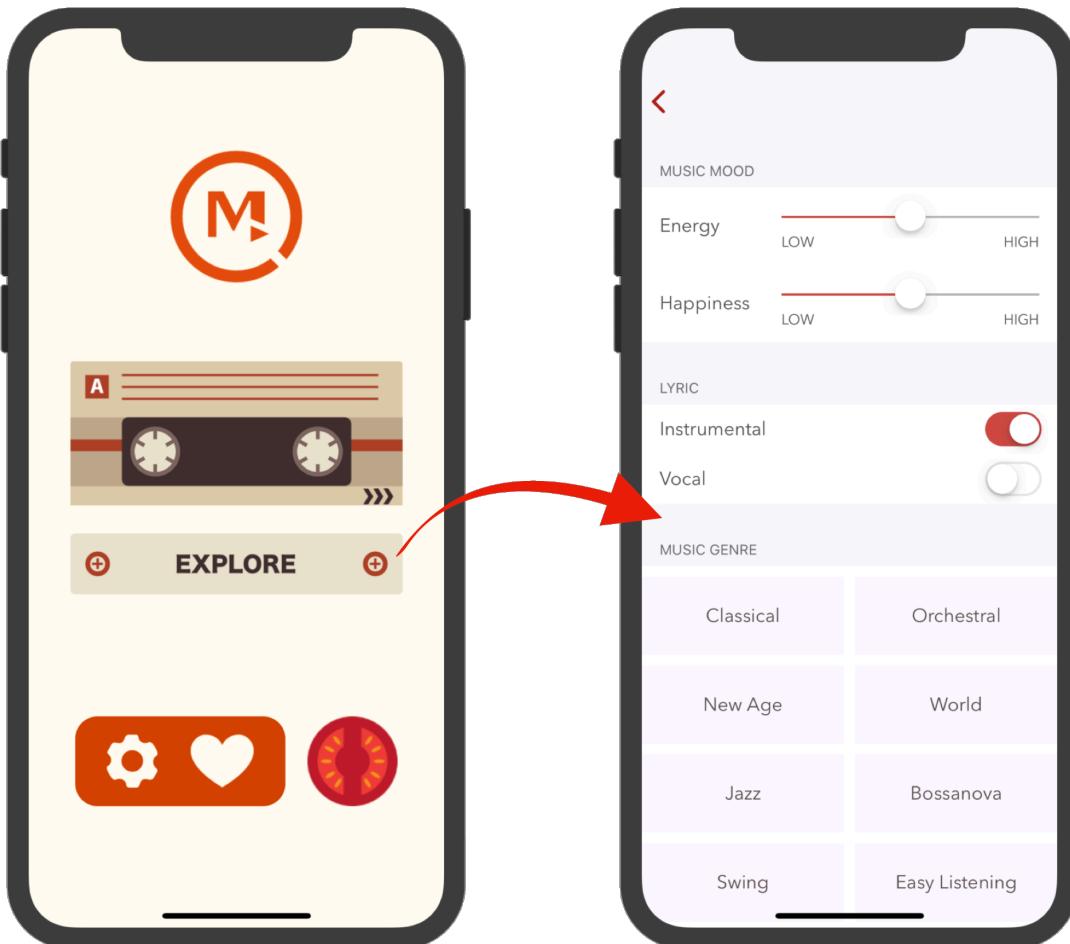
- A Novel Music App: Moody
- Experiment Procedure
- Pop-up Surveys

## **Data Analysis**

- Repeated measures correlation (Bakdash et al., 2016)
- Pearson's Chi-Square test



# Experiment Design: The Music App



- **a large-scale music pool**
  - 10K music pieces
- **mood-based music discovery**
  - energy
  - happiness
- **music filtering**
  - instrumental or vocal
  - music genre (e.g., Classical, Jazz)
- **interactive survey**
  - pop up every 25 min



# Experiment Design: Procedure



## Registration

- demographic info

## Face-to-face instruction

- user instruction
- install Moody

## Field experiment

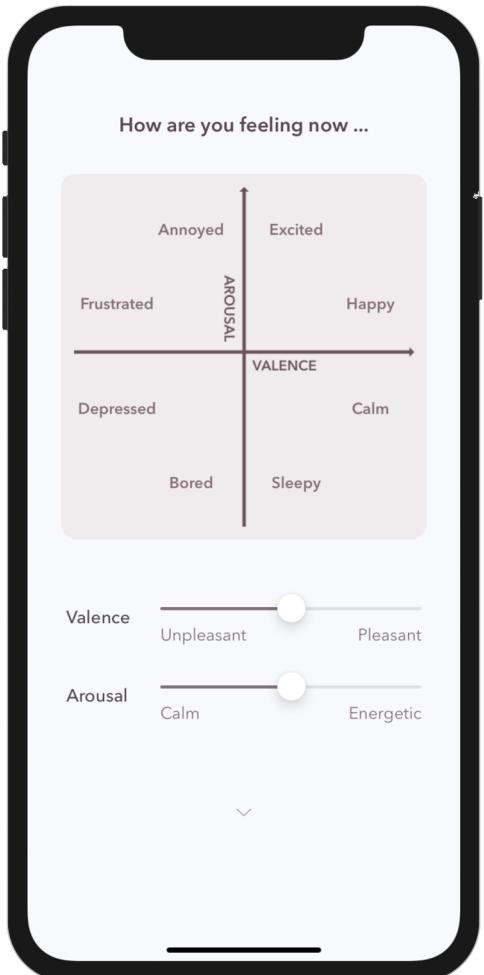
- Learning with music
- Pop-up surveys

## Face-to-face feedback

- listening behavior
- experimental tasks
- Moody

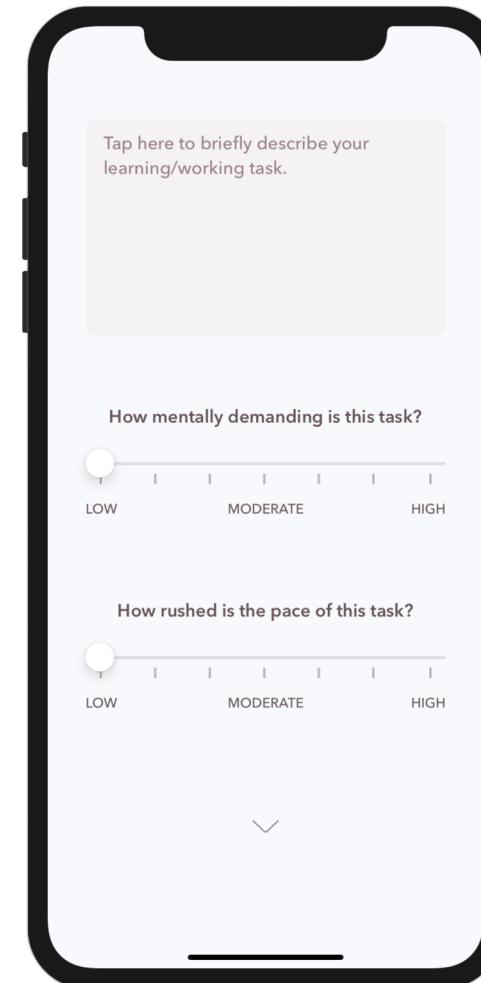


# Experiment Design: Pop-up Surveys



**Emotion**  
Semantic space for  
emotion  
(Scherer, 2005)

**Circumplex model of  
emotion (Russel,  
1989)**



**Scenario**  
Task description  
  
**NASA task load  
index (Hart, 1988)**



# Experiment Design: Pop-up Surveys

The smartphone screen displays a survey titled "Task Engagement". It contains five statements with Likert-scale sliders ranging from "Strongly disagree" to "Strongly agree".

- My attention was focused entirely on what I was doing.
- I had total concentration.
- I was completely focused on the task at hand.
- Time seemed to alter (either slowed down or speeded up).
- It felt like time went by quickly.
- I lost my normal awareness of time.

## Engagement

Adapted Flow state scale  
(Jackson, 2012)

- concentration
- altered sense of time

The smartphone screen displays a survey titled "Task Performance". It asks "To what extent did the music affect your performance on this task?" and provides a Likert scale from "Very much distracted me" to "Very much enhanced my work". Below the scale, a legend maps numbers to descriptions.

To what extent did the music affect your performance on this task?

Very much distracted me

1 = Very much distracted me  
2 = Moderately distracted me  
3 = Slightly distracted me  
4 = Had no effect  
5 = Slightly enhanced my work  
6 = Moderately enhanced my work  
7 = Very much enhanced my work

## Performance

Adapted from Mayfield (1989)



# **Participants and Learning Sessions**

- **30 postgraduate students**
  - 13 males, 17 females
  - diversified majors of study
- **195 valid learning sessions**
  - Exclude: durations  $\leq$  5 min
  - Exclude: with missing data caused by technology failures
  - on average, 6.5 learning session per participant
- **2618 music listening records**
  - 13 songs per session



# Preliminary Results: Role of Music Characteristics

## Music Genre (Metadata provided by the source database, Jamendo)

- 1) Genre & task performance (TP) are associated ( $\chi^2(5) = 24.86$ ,  $p < .001$ )
- 2) Sessions with easy listening music mostly received positive report on TP (71.43%)
- 3) Sessions with pop (54.05%) & classical (70.59%) music received more negative responses on TP

Genres	Perceived learning performance		
	Distract (1-3)	No effect (4)	Enhance (5-7)
Easy listening	14.29%	14.29%	71.43%
Jazz	44.44%	16.67%	38.89%
Rock	47.06%	11.76%	41.18%
Pop	54.05%	16.22%	29.73%
Classical	70.59%	17.65%	11.76%



# Preliminary Results: Role of Music Characteristics

## Fine-grained music features

- 1) Percentage of vocal music
  - $(\# \text{ of vocal music}) / (\# \text{ of songs each session})$
- 2) Acoustic features
  - tempo & rhythm strength
  - LibROSA
- 3) Music emotion
  - happiness & energy
  - predictive modeling of acoustic features using SVM
  - training data from previous study (Hu, 2017)



# Preliminary Results: Role of Music Characteristics

## Fine-grained music features

Happiness and energy were both found to be positively correlated with learning engagement (i.e. concentration, altered sense of time)

Music Features	Repeated Measures Correlation Coefficient		
	Concentration	Sense of Time	Performance
pct_vocal	-.015	.026	-.008
rhythm_str	-.043	-.062	-.095
tempo	-.018	-.116	-.140
happiness	.152*	.159*	.185
energy	.183*	.196*	.105



# Preliminary Results: Relationship between Mood Enhancement and Learning

- 1) change of valence is positively correlated with task performance ( $p = .001$ )
- 2) change of arousal is positively correlated with altered sense of time ( $p = .028$ )

Emotion	Repeated Measures Correlation Coefficient		
	Concentration	Sense of Time	Performance
chg_v	.124	.072	.248**
chg_a	.080	.169*	.067



# Preliminary Results: Role of Personal Music Preference

Finding: underscore the importance of personalised music selection for facilitating learning

Construct	r	p
total concentration	0.316	< .001
altered sense of time	0.3	< .001
perceived learning performance	0.45	< .001



## Summary

- 1) Explores how background music benefits learning through a field experiment
- 2) music characteristics and task engagement & performance are correlated

## Implications

- 1) Provide empirical evidence for the effect of music on learning in naturalistic settings
- 2) Design implications for personalized music recommendation in educational setting



## **Limitations**

- 1) sample size ( $N = 30$ ) is still relatively small
- 2) a lack of diversity in terms of participants' cultural background
- 3) subjectivity and reliability of self-reported measures

## **Future work**

- 1) recruit larger and more culturally diversified samples
- 2) probe potential relationships between learners' traits and music preference during learning



# References

- G. Husain, W. F. Thompson, and E. G. Schellenberg. 2002. Effects of Musical Tempo and Mode on Arousal, Mood, and Spatial Abilities. *Music Perception: An Interdisciplinary Journal*, 20, 2 (2002), 151-171.
- D. Jones. 1999. The cognitive psychology of auditory distraction: The 1997 BPS Broadbent Lecture. *British Journal of Psychology*, 90, 2 (1999), 167-187.
- K. R. Scherer. 2005. What are emotions? And how can they be measured? *Social Science Information*, 44, 4 (2005), 695-729.
- J. A. Russell, A. Weiss, and G. A. Mendelsohn. 1989. Affect grid: a single-item scale of pleasure and arousal. *Journal of personality and social psychology*, 57, 3 (1989), 493.
- S. G. Hart, and L. E. Staveland. 1988. Development of NASA-TLX (Task Load Index): Results of Empirical and Theoretical Research, *Advances in Psychology*. North-Holland, Amsterdam, Netherlands.
- C. Mayfield, and S. Moss. 1989. Effect of Music Tempo on Task Performance. *Psychological Reports*, 65, 3\_suppl2 (1989/12/01 1989), 1283-1290.
- X. Hu, and Y. H. Yang. 2017. Cross-Dataset and Cross-Cultural Music Mood Prediction: A Case on Western and Chinese Pop Songs. *IEEE Transactions on Affective Computing*, 8, 2 (2017), 228-240.
- J. Z. Bakdash, and L. R. Marusich. 2017. Repeated Measures Correlation. *Frontiers in psychology*, 8 (2017), 456-456.



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*Thank you*

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