SleepGAN: Towards Personalized Sleep Therapy Music

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* This work was done at Nokia Bell Labs during the author's internship

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40% UK adults [1]

43% US adults [2]

Cognitive behaviour therapy

Pharmaceutical sleep aids

Expensive

Inconvenient

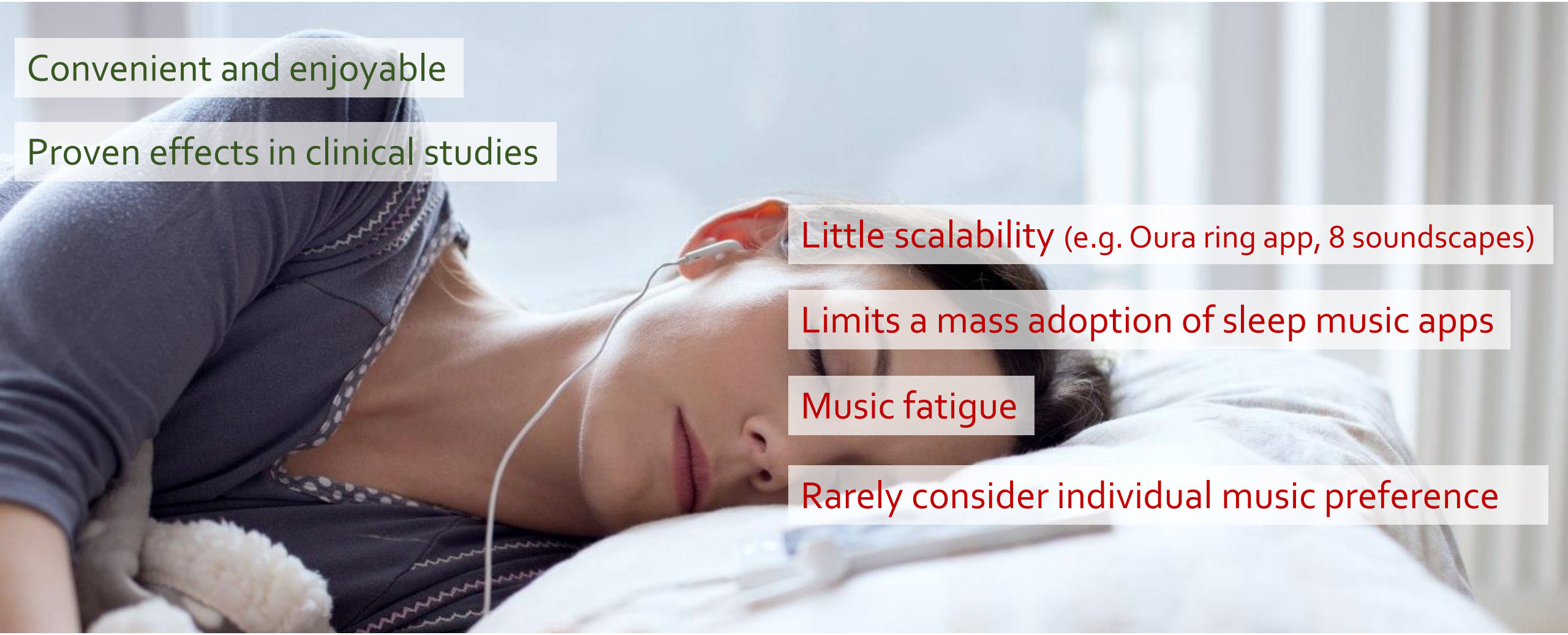
Expert guidance

Potential harmful side-effects

Alternative non-invasive, low-cost, and enjoyable solutions to sleep therapy

[1] Trahan et al., "The music that helps people sleep and the reasons they believe it works: A mixed methods analysis of online survey reports", 2018
[2] CDC declares sleep disorders a public health epidemic

Music Therapy



Convenient and enjoyable

Proven effects in clinical studies

Little scalability (e.g. Oura ring app, 8 soundscapes)

Limits a mass adoption of sleep music apps

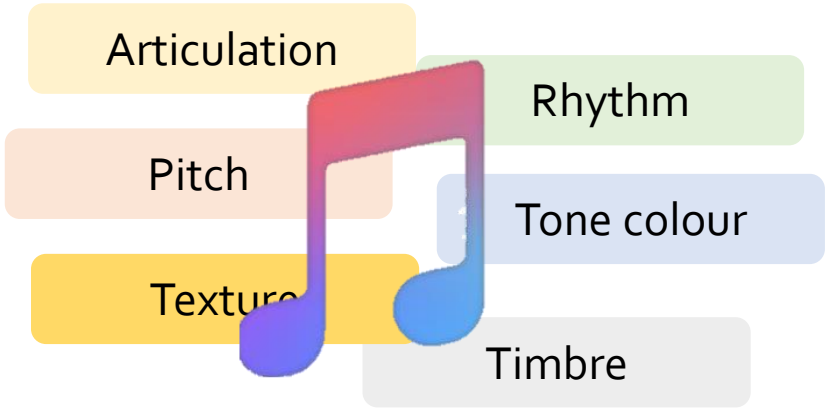
Music fatigue

Rarely consider individual music preference

Personalized sleep music:
Automatically bring therapeutic properties into arbitrary user-preferred music

Challenges

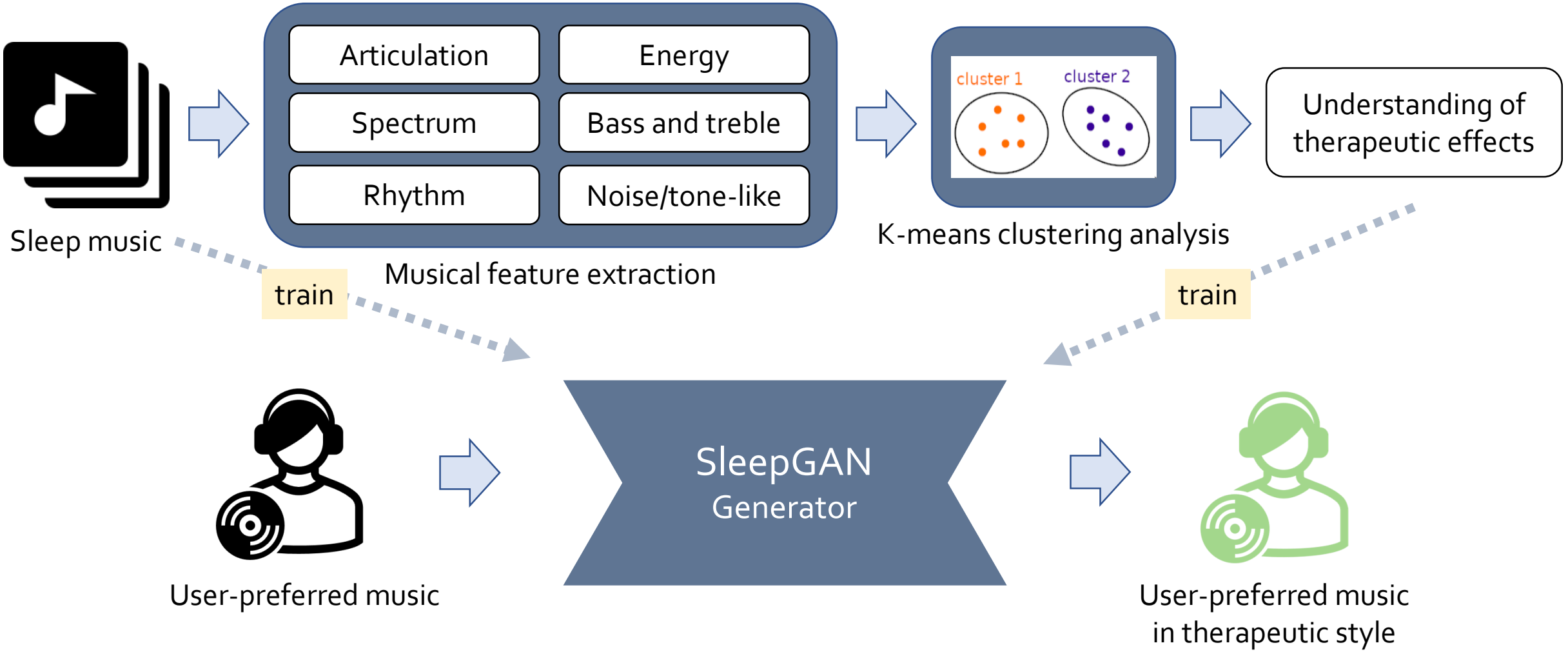
Why so difficult to generate personalized sleep music?



RQ1: What musical features contribute the therapeutic effects of sleep music?

RQ2: How to bring such therapeutic sleep features into user-selected music?

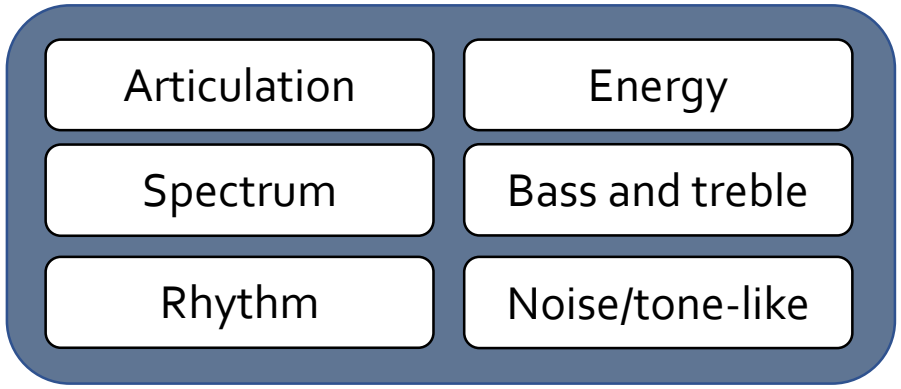
Overview of Our Approach



Musical Feature Analysis

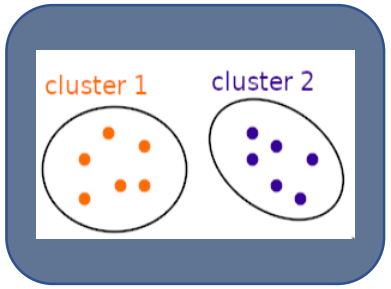
Sleep music

Other music styles (e.g. jazz, pop, metal)



$$V_{musical} = [f_1, f_2, \dots\dots f_{33}, f_{34}]$$

Adjusted Rand Score (ARS):
Clustering accuracy



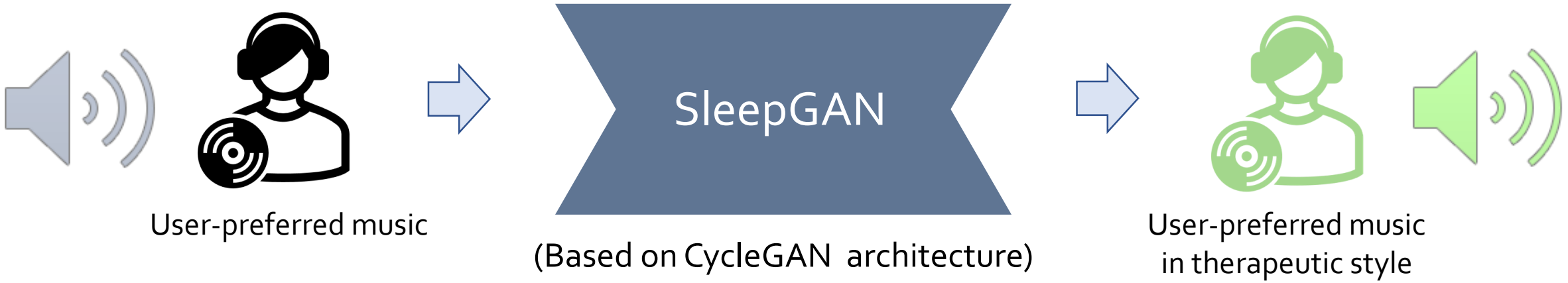
Understanding of therapeutic effects

	ARS
All 34 musical features	0.115
Only articulation and energy features	-0.063
Only MFCC features	0.096
Only rhythm features	0.112
Only spectral rolloff features	0.761
Only spectral flatness features	0.037

Bass, treble, overall pitch profile

$$\boldsymbol{w} = [w_1, w_2, \dots\dots w_{33}, w_{34}]$$

Therapeutic Style Transfer



User-preferred music

(Based on CycleGAN architecture)

User-preferred music in therapeutic style

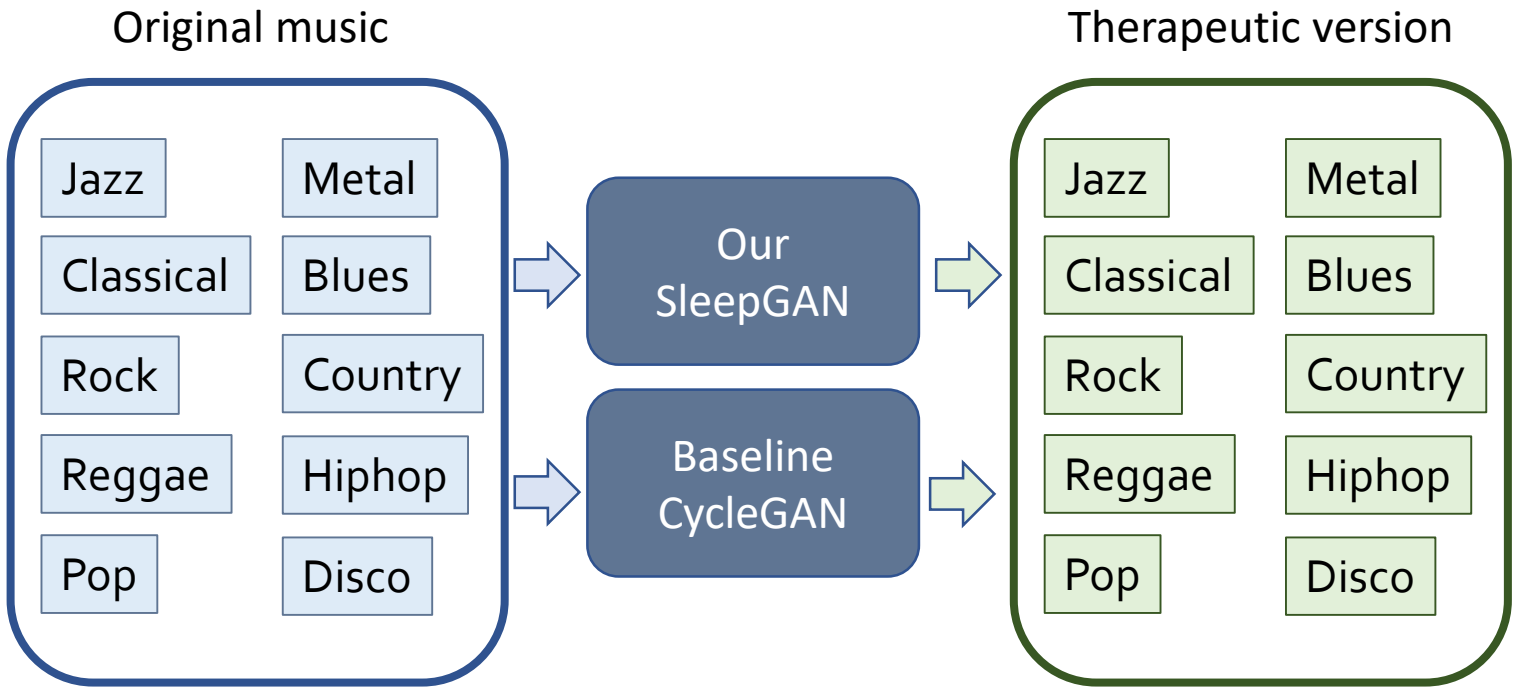
$$L_{GAN} + L_{cycle} + L_{id} + L_{musical}$$

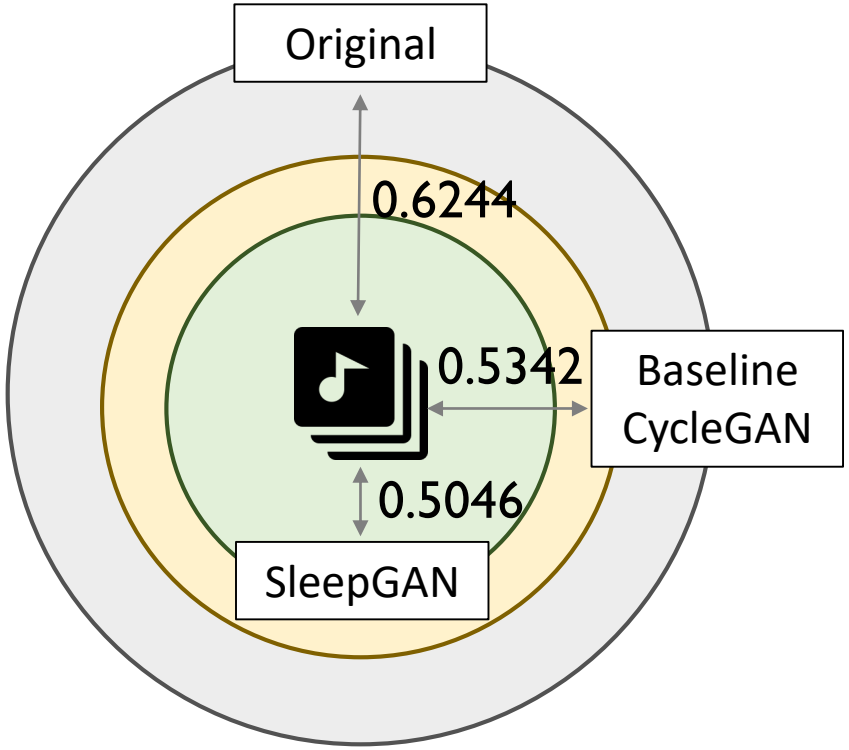
$$L_{musical} = f(V_{musical} \times \vec{w})$$

$$V_{musical} = [f_1, f_2, \ldots\ldots f_{33}, f_{34}]$$

Therapeutic Style Transfer: Evaluation

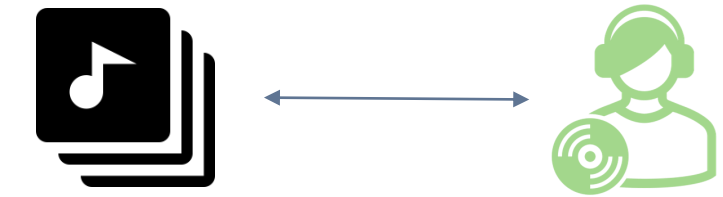
Objective evaluation target: model-converted music becomes **closer** to sleep music





Therapeutic Style Transfer: Evaluation

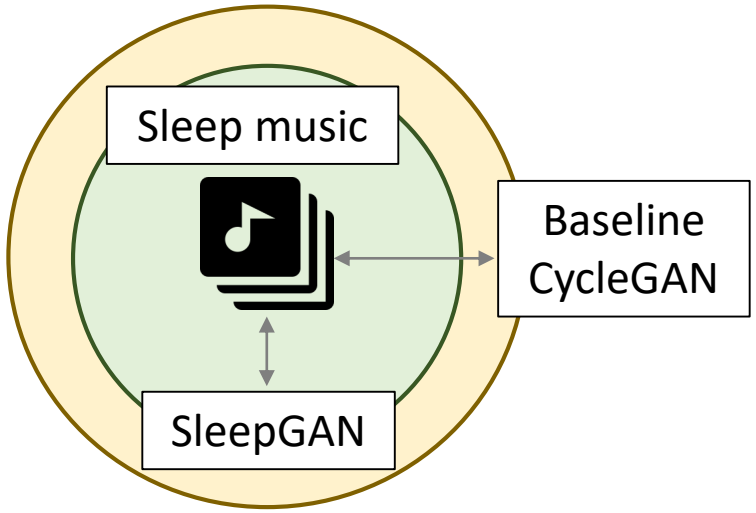
Subjective evaluation with 11 participants (2 female, 9 male)



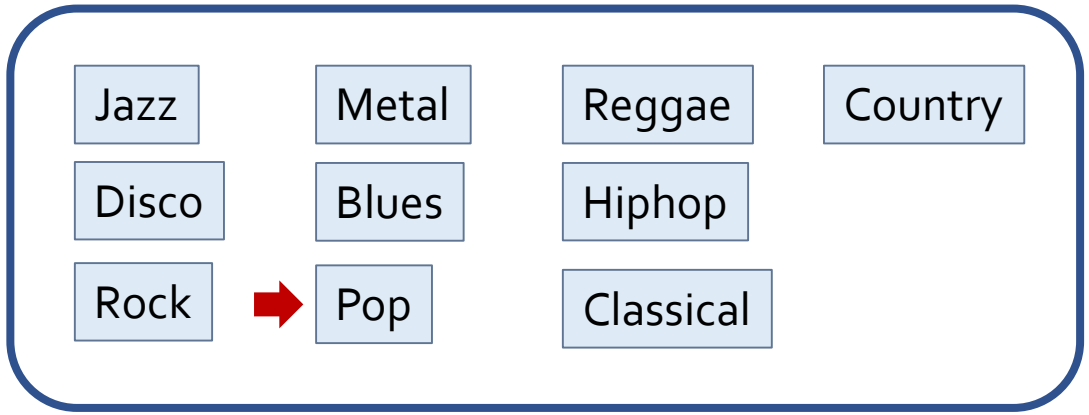
Sleep music

Model-converted music

Perceived style similarity



Music genres



More studies to explore the musicality and clinical effects

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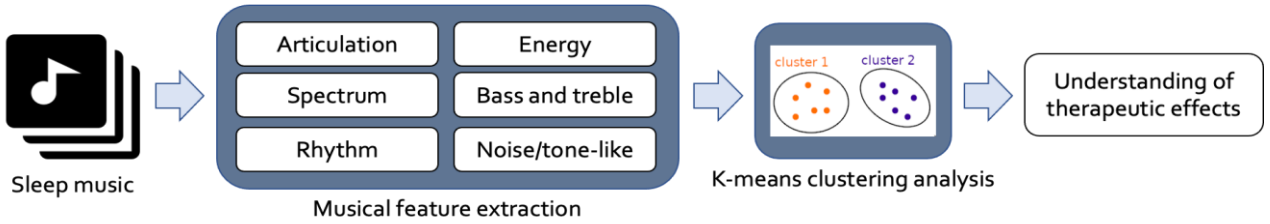
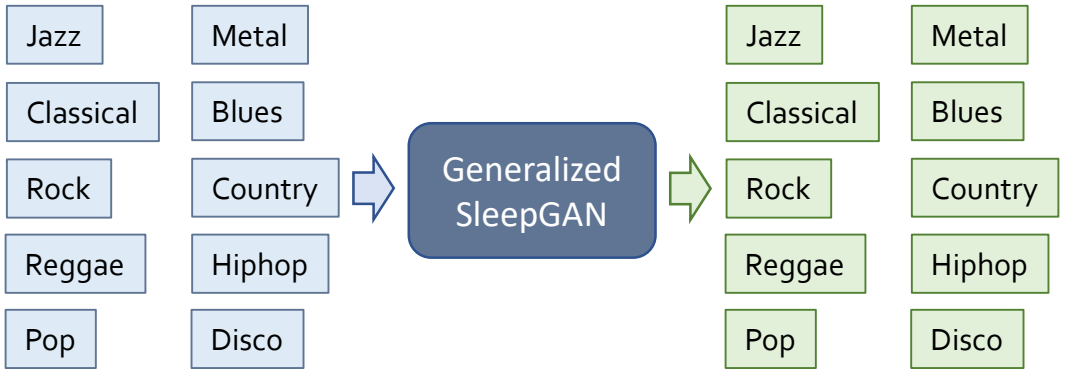
Take-aways:



T1: Bass, treble, and overall pitch profile of music

T2: Music style transfer for creating personal therapy music

Future work:



Thank You

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