

The Effect of an Affective Music Recommendation System and Auditory Beat Stimulation on Anxiety

Ryerson
University

Mitacs

Adiel Mallik¹, Zoe Thomson², and Frank Russo¹

¹Department of Psychology, Ryerson University, Toronto, Ontario, Canada ²Lucid, Inc., Toronto, Ontario, Canada

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Introduction

- Chronic anxiety is a growing psychological challenge worldwide and at pre-clinical levels can be disabling [1].
- Some research suggests music may reduce anxiety symptoms as effectively as anti-anxiety drugs without the adverse side-effects [2].
- Auditory beat stimulation (ABS) is an auditory illusion that can be perceived when two or more pure-tone sine waves of similar but different frequencies are presented through stereo headphones [3].
- For example, a two-tone exposure of 400 and 405 Hz presented in each ear separately will be perceived as a single tone with a frequency of 5 Hz [3].
- ABS (4-7 Hz) may also reduce anxiety [4].
- Here, the anxiety-reducing potential of calm music curated by an affect-based AI agent with theta ABS was examined.

Methods

Participants

- Participants (n=318) taking anti-anxiety medication were recruited using the online participant pool Prolific and randomly assigned to one of four separate experimental sessions: music & ABS, music, ABS, and pink noise.
- There were 86 males, 232 females.
- Mean age of participants was 28.95 years.
- All participants completed the following measures prior to their assigned intervention:
 - Short Test of Musical Preferences (STOMP)
 - Short form of the Eysenck Personality Inventory
 - STICSA somatic and cognitive trait anxiety
- All participants completed the following measures pre- and post-intervention:
 - STICSA somatic and cognitive state anxiety

Experimental Procedure

- After consenting to the study, participants then downloaded the LUCID Research Application on their iOS device.
- Participants then completed the pre-intervention survey prior to completing their assigned intervention.
- Participants listened to their assigned intervention for 24 minutes.
- Participants then completed the post-intervention survey.

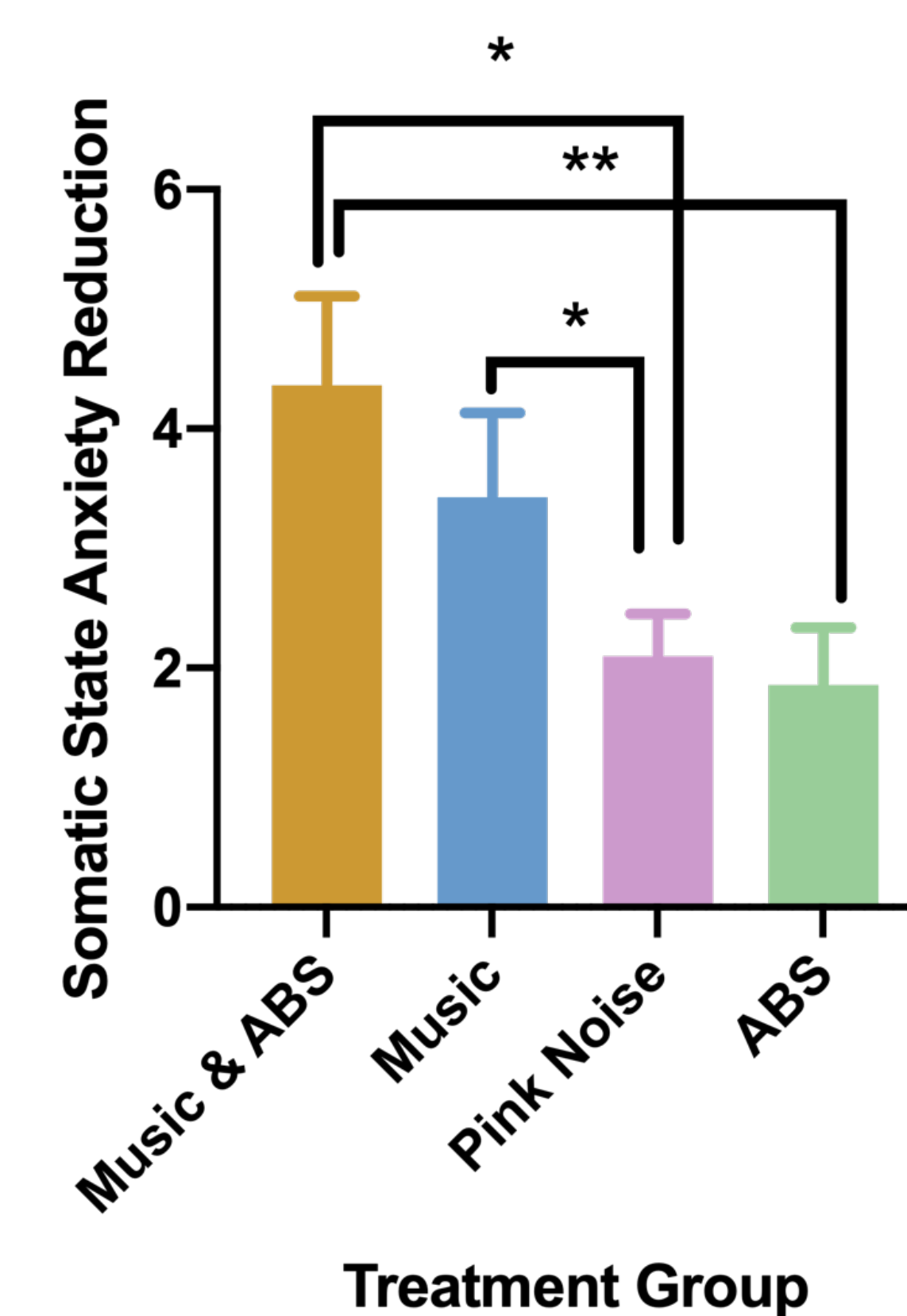
Results

Multiple Linear Regression

- Multiple linear regression showed that the relationship between STICSA state anxiety reduction and STICSA trait anxiety was significant ($p < 0.05$).
- Participants were separated into moderate and high trait anxiety groups prior to analysis.
- Prior work establishes the following thresholds for STICSA trait [5]:
 - Moderate anxiety
 - STICSA trait somatic score between 16.9 and 22.4
 - STICSA trait cognitive score between 17.1 and 26.6
 - High anxiety
 - STICSA trait somatic score of 22.4 and above
 - STICSA trait cognitive score of 26.6 and above

Moderate Trait Anxiety Participants

A) Somatic State Anxiety Reduction
Moderate Trait Anxiety Participants



B) Cognitive State Anxiety Reduction
Moderate Trait Anxiety Participants

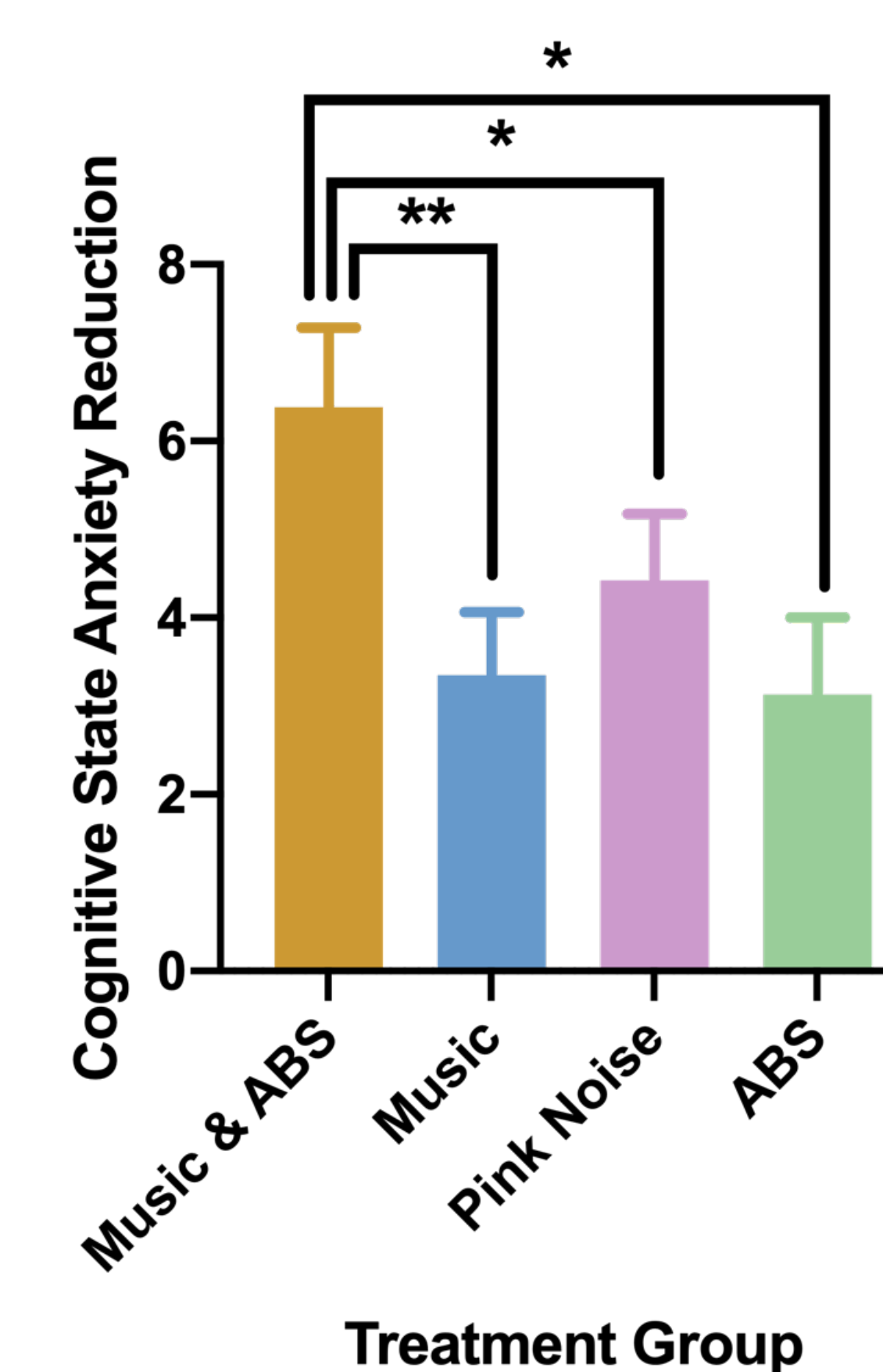


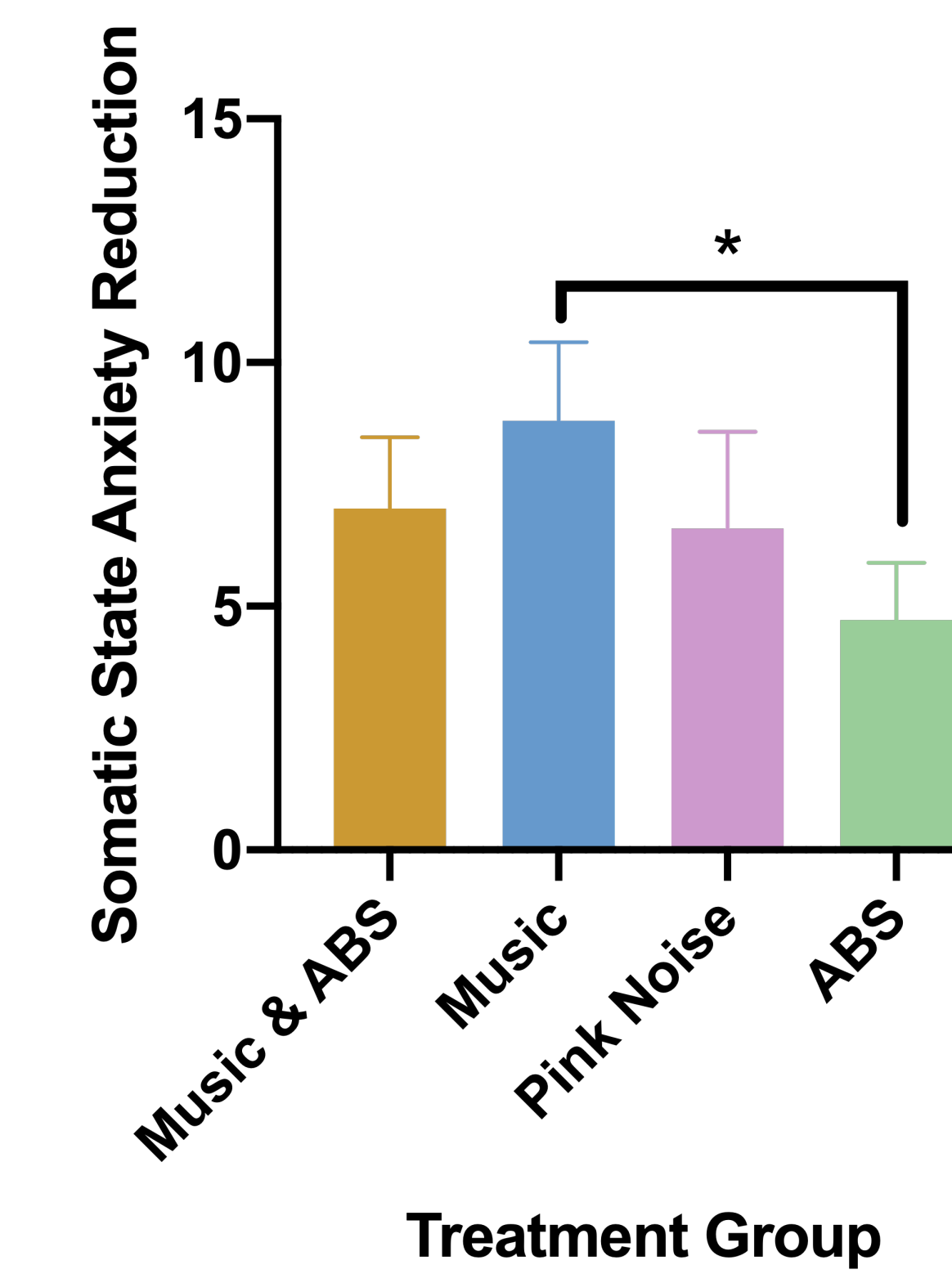
Figure 1: Anxiety reduction in moderate trait anxiety participants for A) Somatic state anxiety reduction and B) Cognitive state anxiety reduction (* denotes $p < 0.05$, ** denotes $p < 0.01$ by Fisher Randomization Test (5000 iterations))

- In moderate trait anxiety participants, the music & ABS and music groups have significantly higher somatic state anxiety reduction than the pink noise and ABS groups (Figure 1A).
- The music & ABS group had significantly higher cognitive state anxiety reduction compared to the music, pink noise and ABS groups in moderate trait anxiety participants (Figure 1B).

Results

High Trait Anxiety Participants

A) Somatic State Anxiety Reduction
High Trait Anxiety Participants



B) Cognitive State Anxiety Reduction
High Trait Anxiety Participants

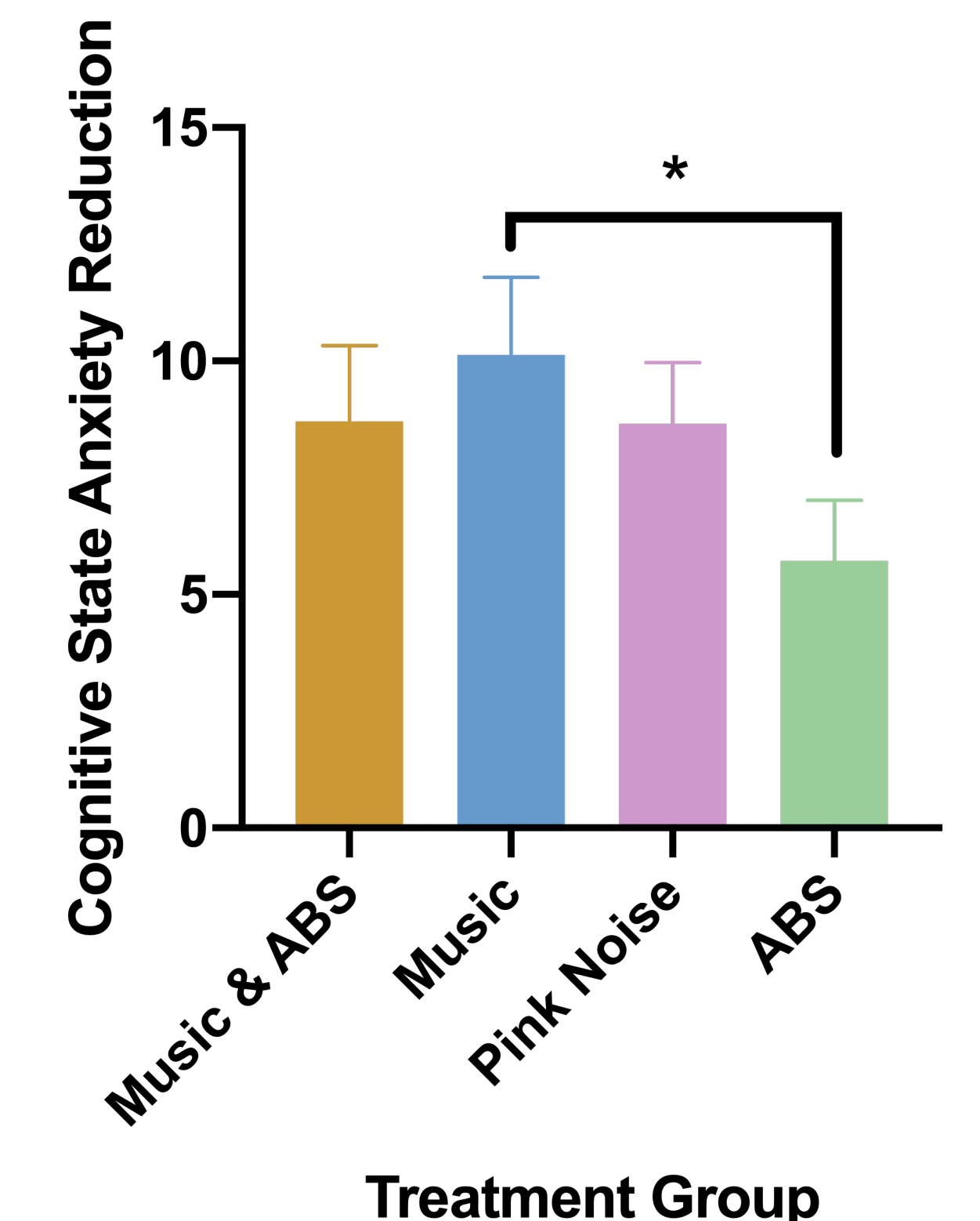


Figure 2: Anxiety reduction in high trait anxiety participants for A) Somatic state anxiety reduction and B) Cognitive state anxiety reduction (* denotes $p < 0.05$ by Fisher Randomization Test (5000 iterations))

- In high trait anxiety participants the music group had significantly higher state somatic (Figure 2A) and state cognitive (Figure 2B) reduction compared to the ABS group.
- There were no significant differences between any of the music groups (Music, Music & ABS) and pink noise in state somatic and state cognitive anxiety.

Discussion & Conclusion

- Moderate trait anxiety participants had more significant reductions in somatic anxiety in the music treatment groups compared to those with high trait anxiety.
 - High anxiety participants may require a longer and more frequent music interventions to achieve a reduction in anxiety.
- Moderate trait anxiety participants in music treatment groups had significant decreases in somatic state anxiety and music & ABS had higher cognitive state anxiety reduction compared to all groups.
 - Music reduces heart rate, respiration rate, sweat production, body temperature, muscle tension which are the same physiological activities associated with reducing somatic anxiety [6].
 - Somatic anxiety predicts responses to acute stressors (panic), cognitive anxiety predicts responses to chronic stressors (worry).
 - The theta ABS component of the Music & ABS condition may have contributed to reducing cognitive anxiety by entraining endogenous oscillations that are characteristic of relaxation [7].
- A longitudinal study with music interventions is being planned to further explore these questions.

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