Effects of Music on Measures of Arousal, Mood, Attention, and Memory: An Age-Related Study

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Introduction

Research has shown that music can significantly affect mood and arousal (e.g., Waldon, 2001; Hamel,2001). Music's effects on cognitive function, however, have been less clearly established. Rauscher et al. (1993) found that performance on spatial reasoning tasks improved in the context of Mozart music. Other studies (e.g., Steele et al., 1999) have failed to replicate such findings, leading many to question this so-called "Mozart Effect."

To make sense of these equivocal results, researchers have begun to specifically examine the relation between music's effects on mood and arousal and subsequent changes in cognitive performance. Thompson et al. (2001) found working memory performance significantly improved under music conditions that induced positive mood and high arousal. Greene et al. (2010) found that recognition memory performance significantly improved under music conditions that induced either positive mood and high arousal *or* negative mood and low arousal.

Given that the participants in these studies were healthy young adults, it would be reasonable to expect that music's effects might be magnified in a neurologically vulnerable population, such as healthy elderly who show cognitive decline. However, to date, only one study (Mammarella et al., 2007) has investigated the effects of music on cognition in healthy elderly, and none have assessed the effects of aging by comparing changes in cognitive performance in young and elderly adults. Moreover, none have examined music's effects across tasks designed to assess different aspects of cognitive function.

Aims of Current Study

The present study seeks to gain a more global understanding of how music might affect psychological states and multiple cognitive functions in healthy young and elderly adults.

1. **Assess whether two different musical selections can induce differential changes in mood and arousal (positive & high vs. negative & low)**
2. **Examine how the musical selections impact performance in cognitive tasks of: (a) Alerting and Orienting; (b) Working Memory and Executive Control; and (c) Recognition Memory**
3. **Determine the degree to which music's effects differ across healthy young and elderly adults**

Methods

Participants
- 21 Healthy Young Controls (18-24 yrs)
- 20 Healthy Elderly Controls (60-80 yrs)
  - matched on neuropsychological status, education, gender ratio, music experience

Experimental Conditions
- Baseline (Silent)
- Low Energy (*Albinoni*)
  - Adagio in G Minor for Strings and Organ
- High Energy (*Mozart*)
  - Sonata for Two Pianos in D Major, K. 448

Procedure
- Repeated-measures design; 3 test sessions:
  - spaced 1-2 days apart
  - test time consistent (+/- 2 hrs)
- **Music condition order counterbalanced across subjects**

Order of Events in Each Session
- Pre VAMS
- Word Study Phase
- Face Study Phase
- **Exposure 1 (8 min)***
- Post VAMS
- Face Recognition Task
- **Exposure 2 (2 min)***
- Word Recognition Task
- Attention Task
- **Exposure 3 (2 min)***
- Digit Span Task
- Phonemic Fluency Task

* Also measured Skin Conductance and EEG

Task Accuracies

Attention

	Silent	Low	High
YC	0.98 (0.01)	0.97 (0.02)	0.98 (0.02)
EC	0.99 (0.01)	0.99 (0.01)	.99 (0.01)

Recognition Memory

		WORDS				FACES	
	Silent	Low	High		Silent	Low	High
YC	0.80 (0.14)	.80 (0.16)	.80 (0.19)	YC	0.78 (0.15)	0.77 (0.17)	0.77 (0.18)
EC	.83 (0.12)	.83 (0.12)	.78 (0.18)	EC	0.66 (0.16)	0.72 (0.11)	0.64 (0.20)

Arousal/Mood

Visual Analog Mood Scale (VAMS)
- indirect measure of music's effects

Arousal Subscales
Tired & Energetic

Mood Subscales
Happy & Angry
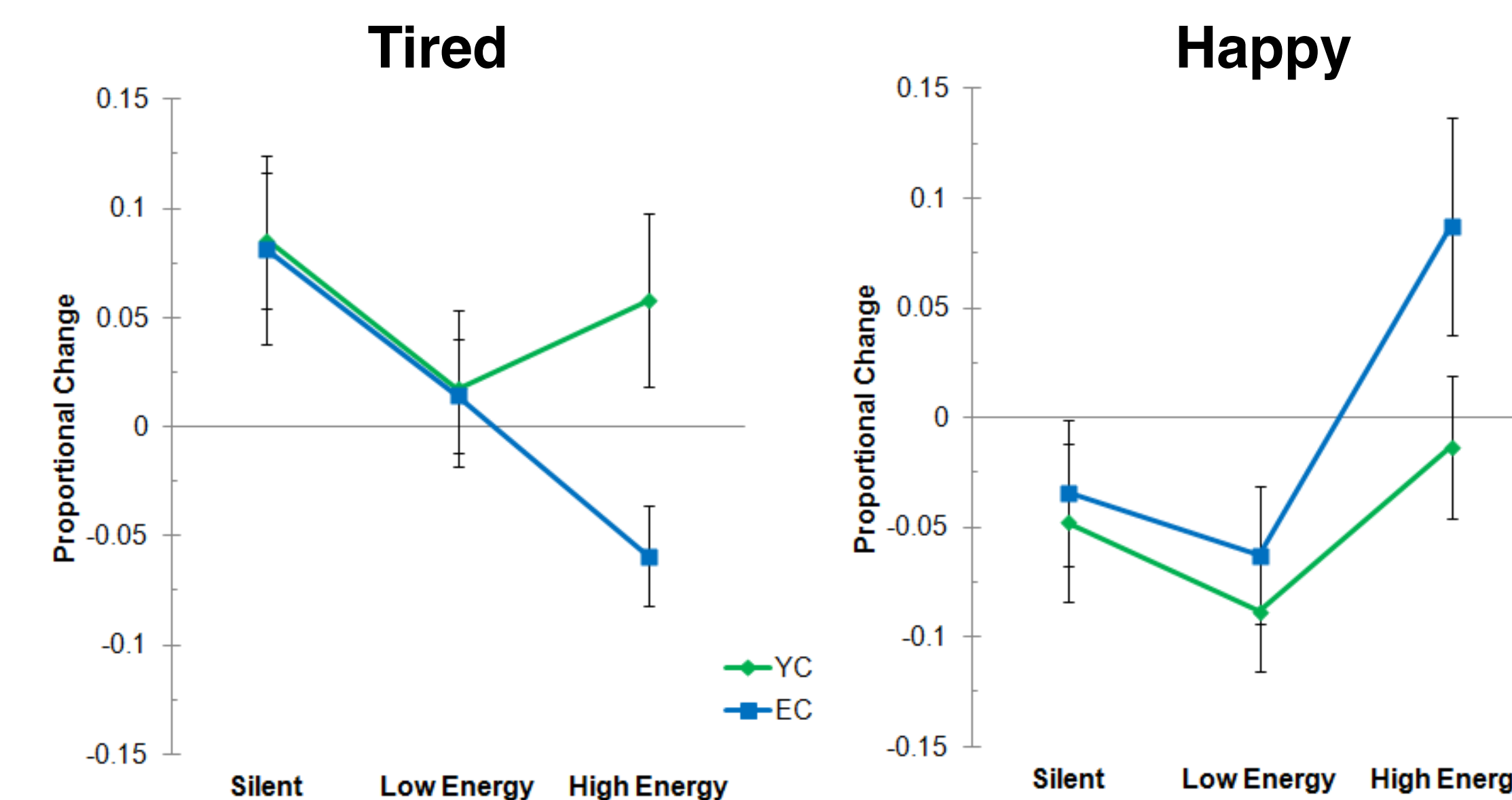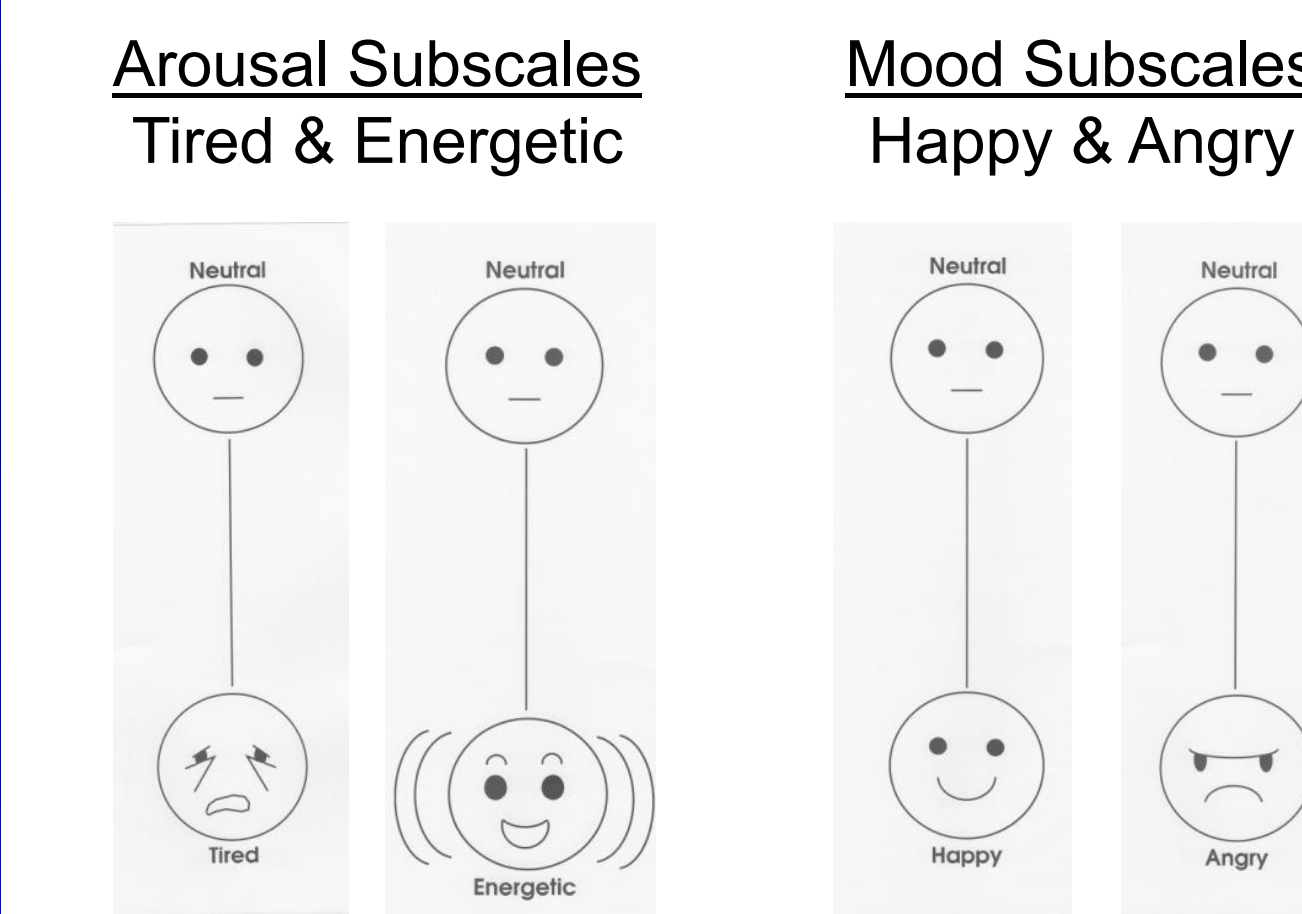
Tired

Happy

Arousal: YC & EC got less tired under Low Energy; EC show additional benefit of High Energy Music
Mood: YC got significantly less happy under Low Energy compared to Silent; EC got significantly happier under High Energy
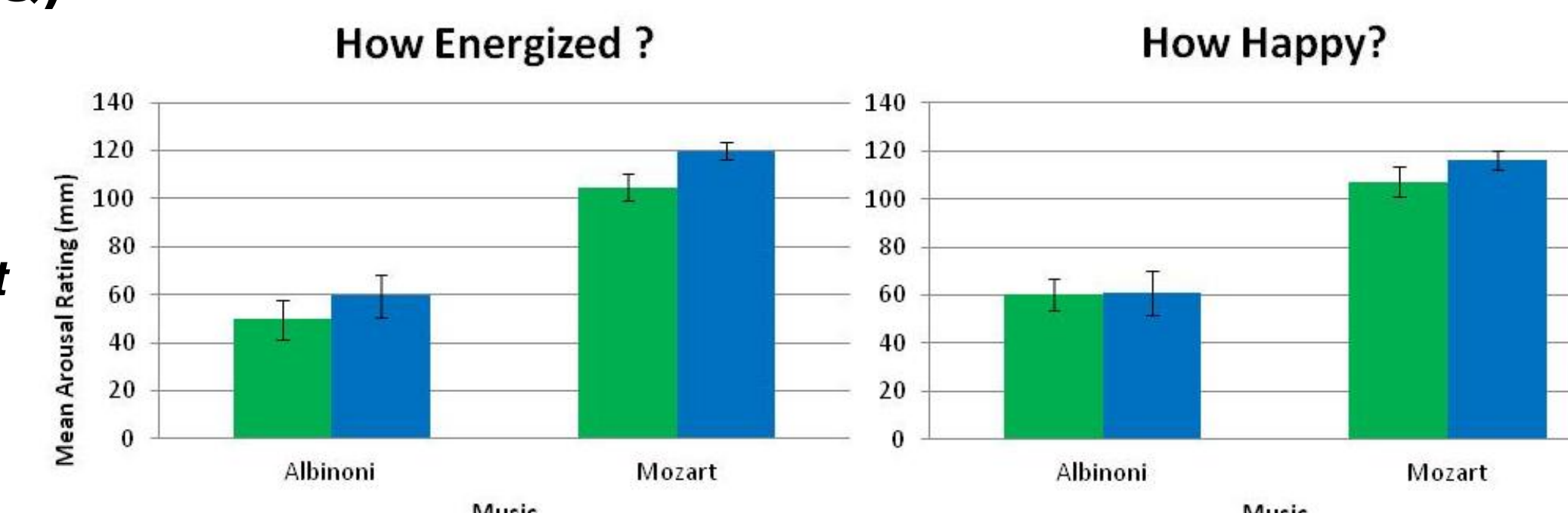
Musical Experiences Questionnaire (MEQ)
- direct measure of music's effects administered at end of final test session

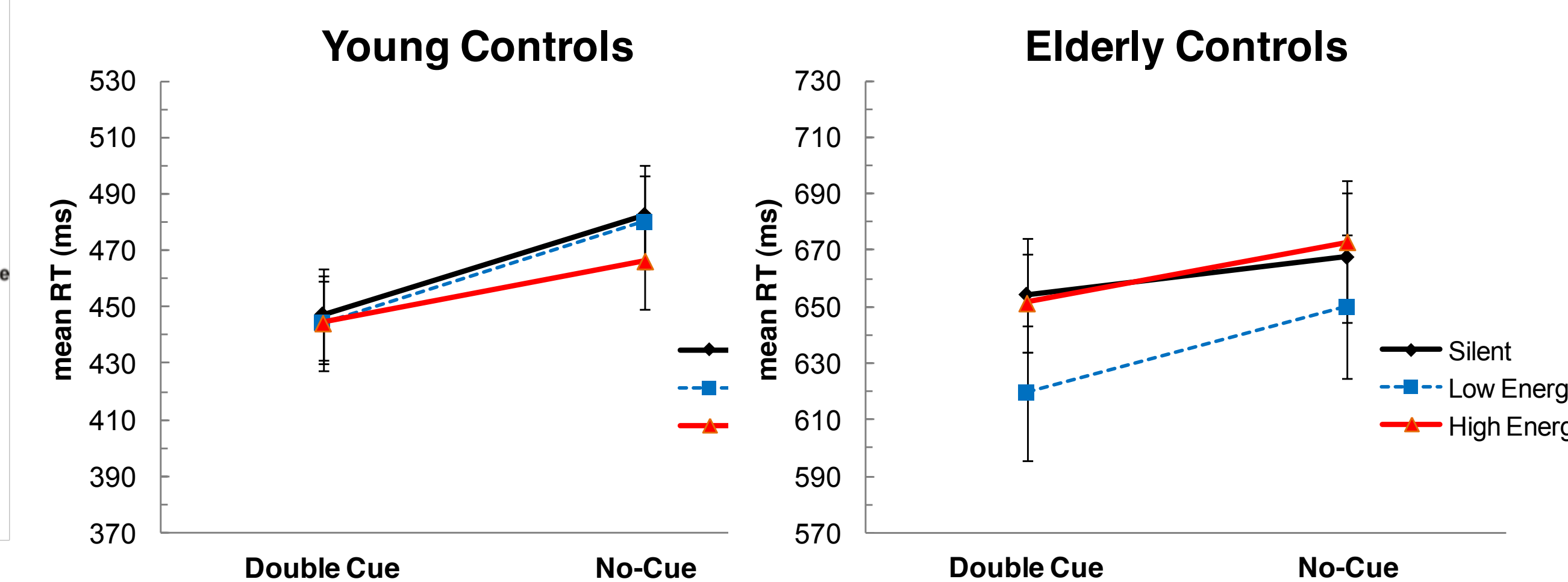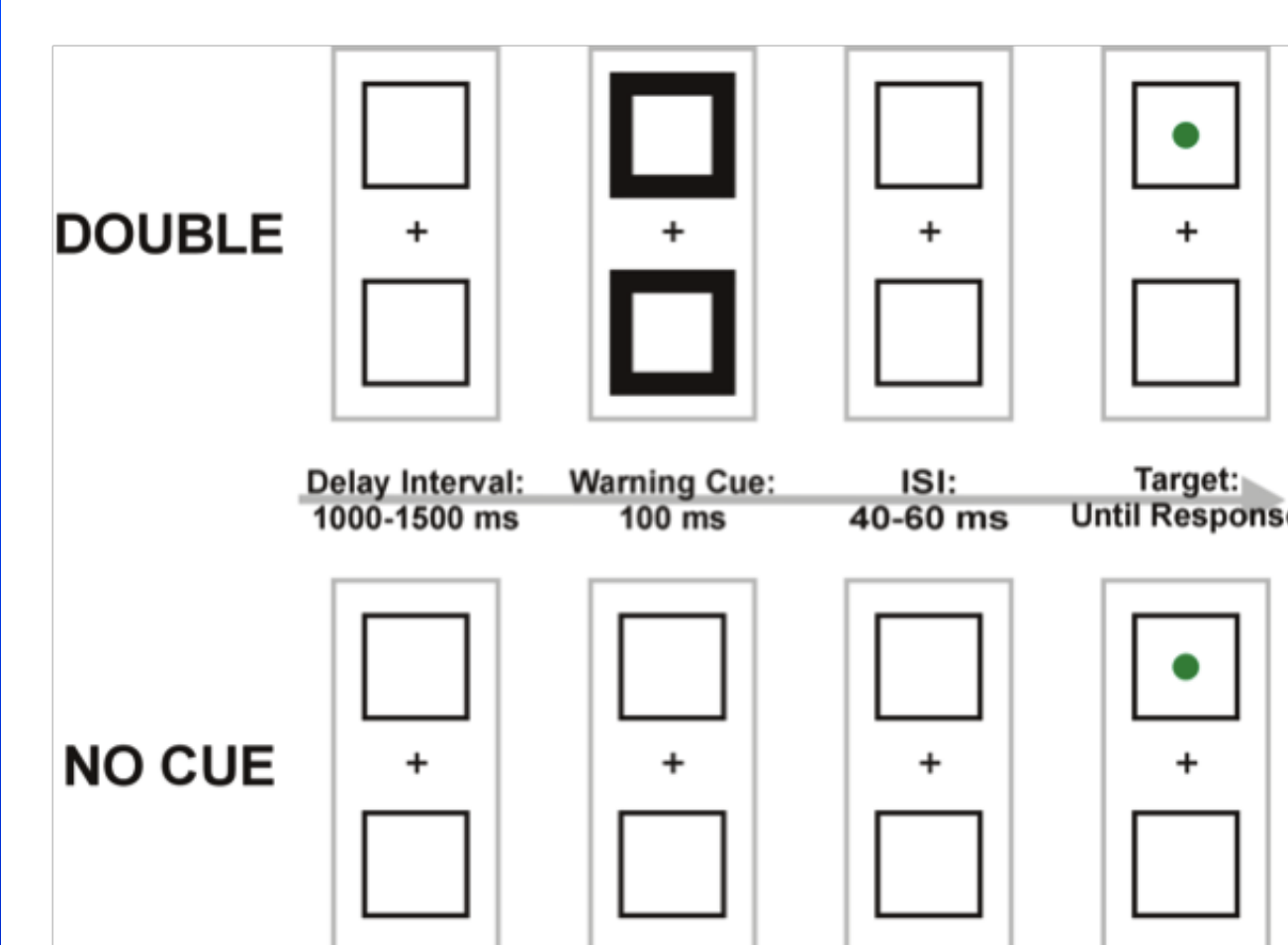*"Place a mark on the line indicating how **energized/alert** this piece makes you feel."*

Not at all — Extremely

*"Place a mark on the line indicating how **happy** this piece makes you feel."*

Not at all — Extremely

How Energized ?

How Happy?

MEQ Ratings: Both groups rated the Mozart as significantly more arousing and energizing than the Albinoni.

Alerting Conditions

DOUBLE

NO CUE

Delay Interval: 1000-1500 ms | Warning Cue: 100 ms | ISI: 40-60 ms | Target: Until Response
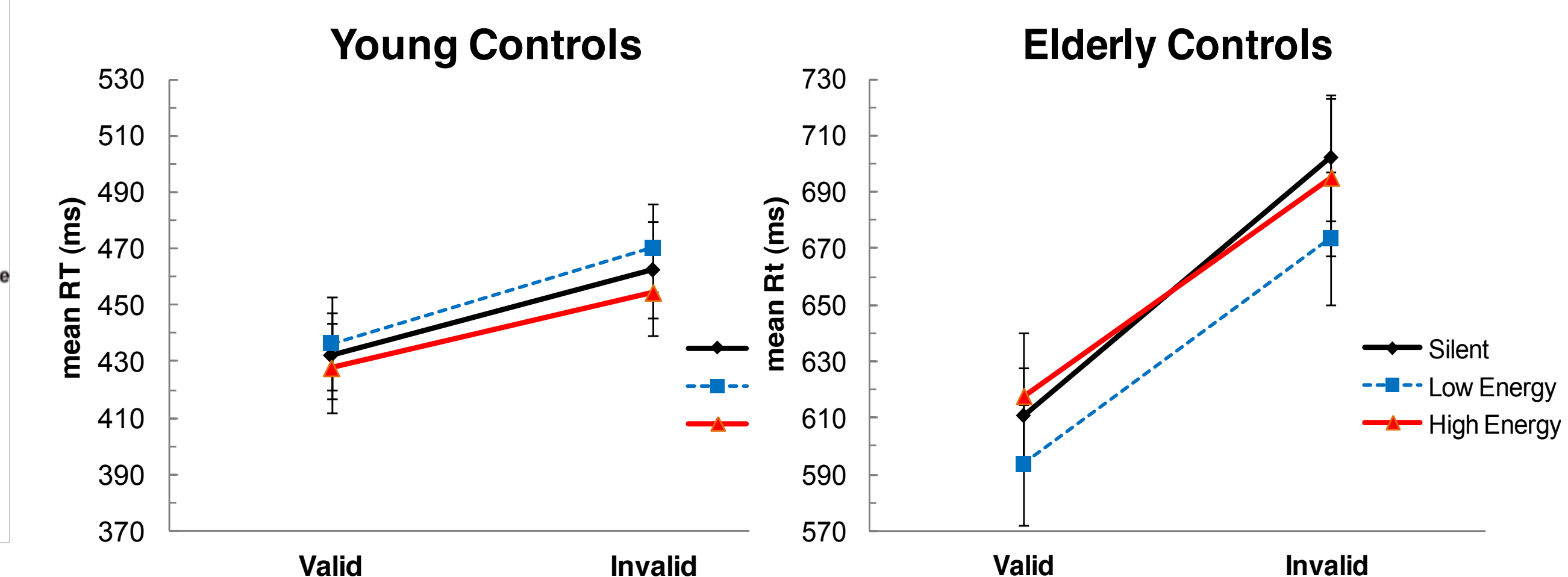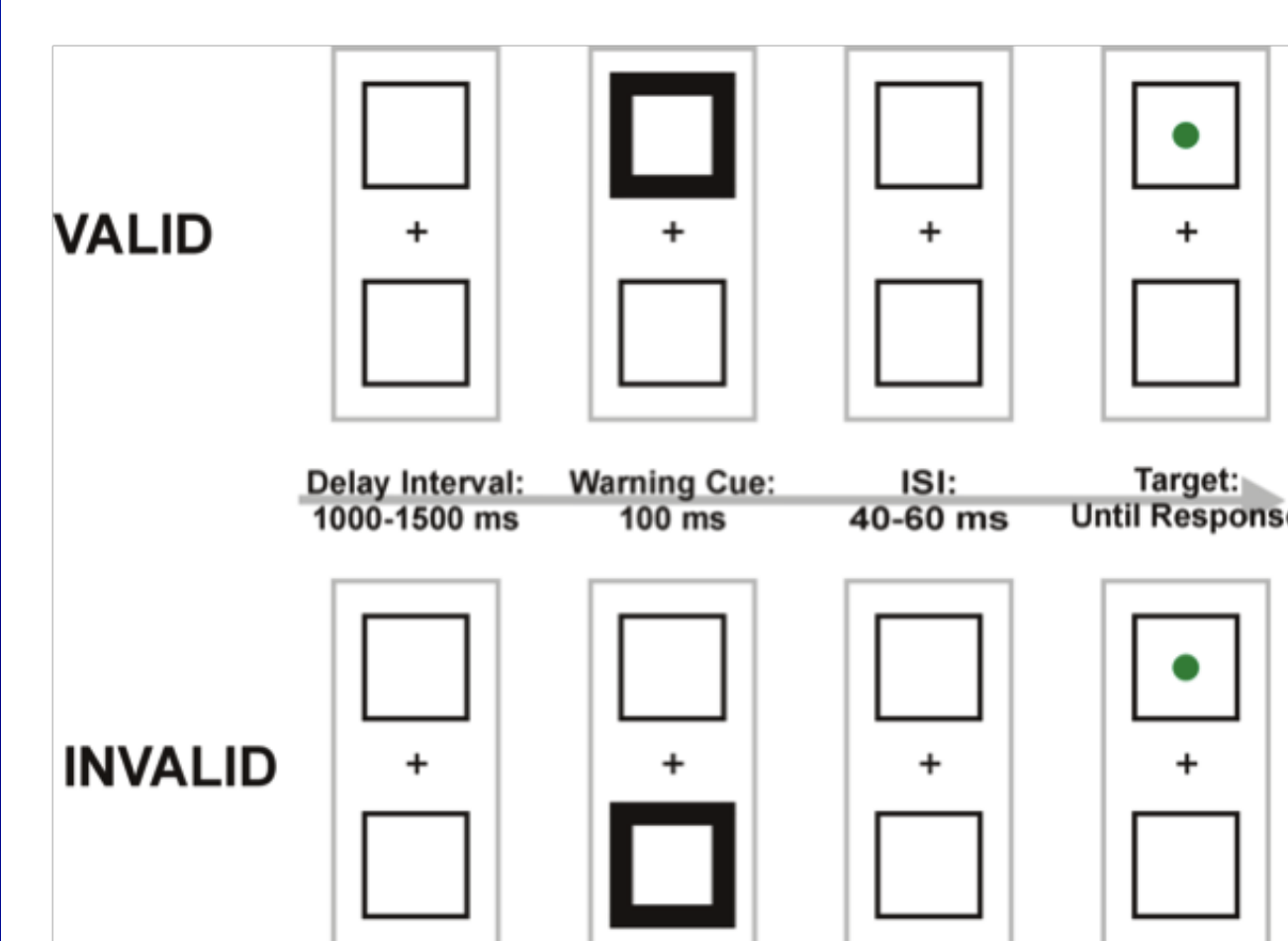
Young Controls

Elderly Controls

Alerting Reaction Times:
YC – High Energy Music significantly decreased RTs in No-Cue condition (reflects increase in tonic arousal only)
EC – Low Energy Music significantly decreased RTs in Double & No Cue conditions (reflects increase in both phasic & tonic arousal)

Orienting Conditions

VALID

INVALID

Delay Interval: 1000-1500 ms | Warning Cue: 100 ms | ISI: 40-60 ms | Target: Until Response

Young Controls

Elderly Controls

Orienting Reaction Times:
YC – High Energy Music significantly decreased RTs, specifically in Invalid Cue Conditions
**EC** – Low Energy Music significantly decreased RTs, in both Valid and Invalid Cue Conditions

Working Memory/Executive Control

Digit Span

Task: Presented with 2 number sequences for each span length (2 to 9 digits)
*Digit Span Score* = total # of points for each correct digit (score 12 ~ WM span 7)

Digit Span: Overall greater Score for YC than EC group (both within normal range); no effect of music on performance in either group
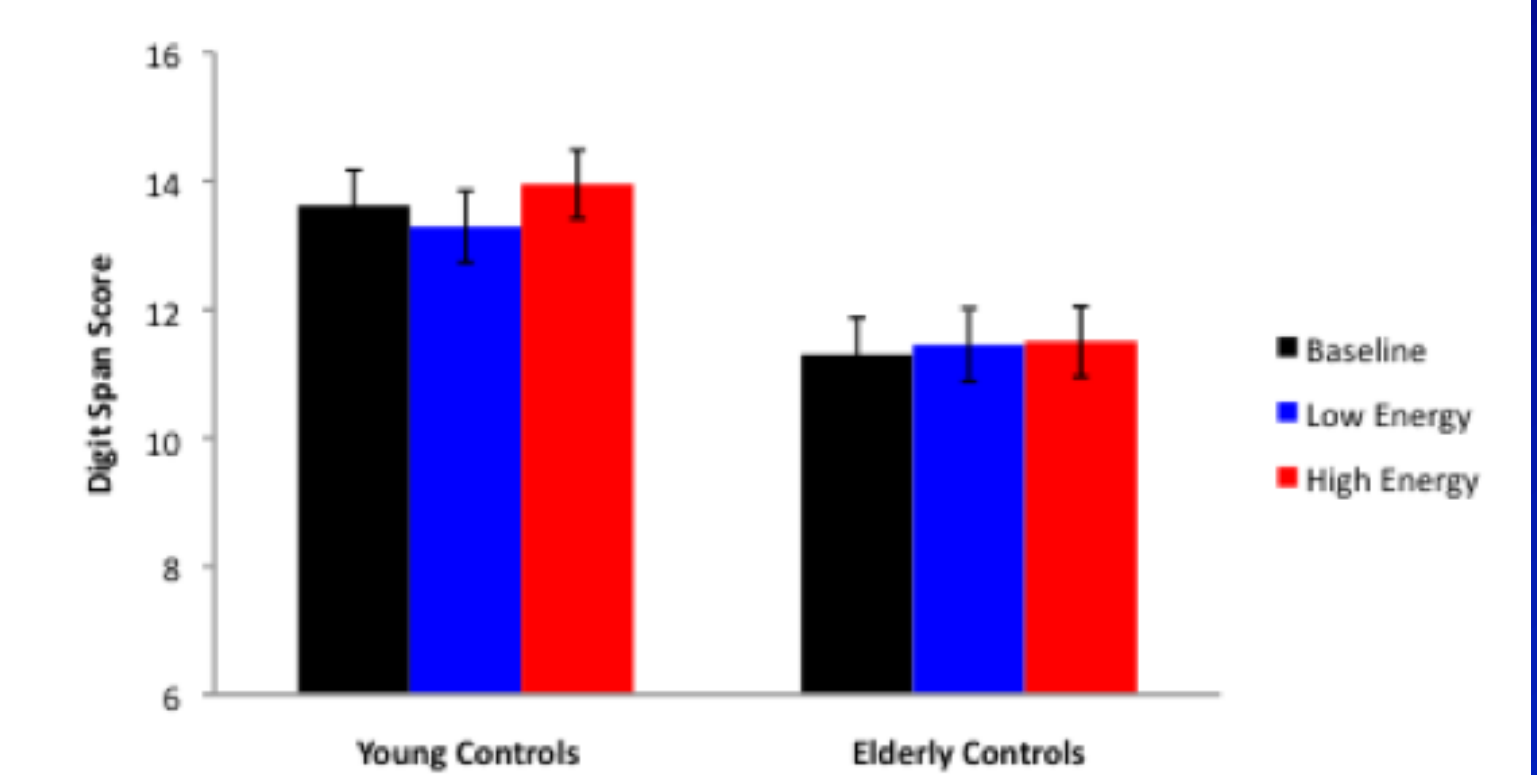
Phonemic Fluency

Task: Presented with a letter and asked to say as many words that start with that letter in 1 min; repeated for letters (*F, A, S*) (*e.g. F*: "*farm, fresh, funny…*")
Fluency Score = (# words for F + A + S)/3

Fluency : Overall greater Score for YC than EC group;
YC: Low & High Energy Music improved fluency equally
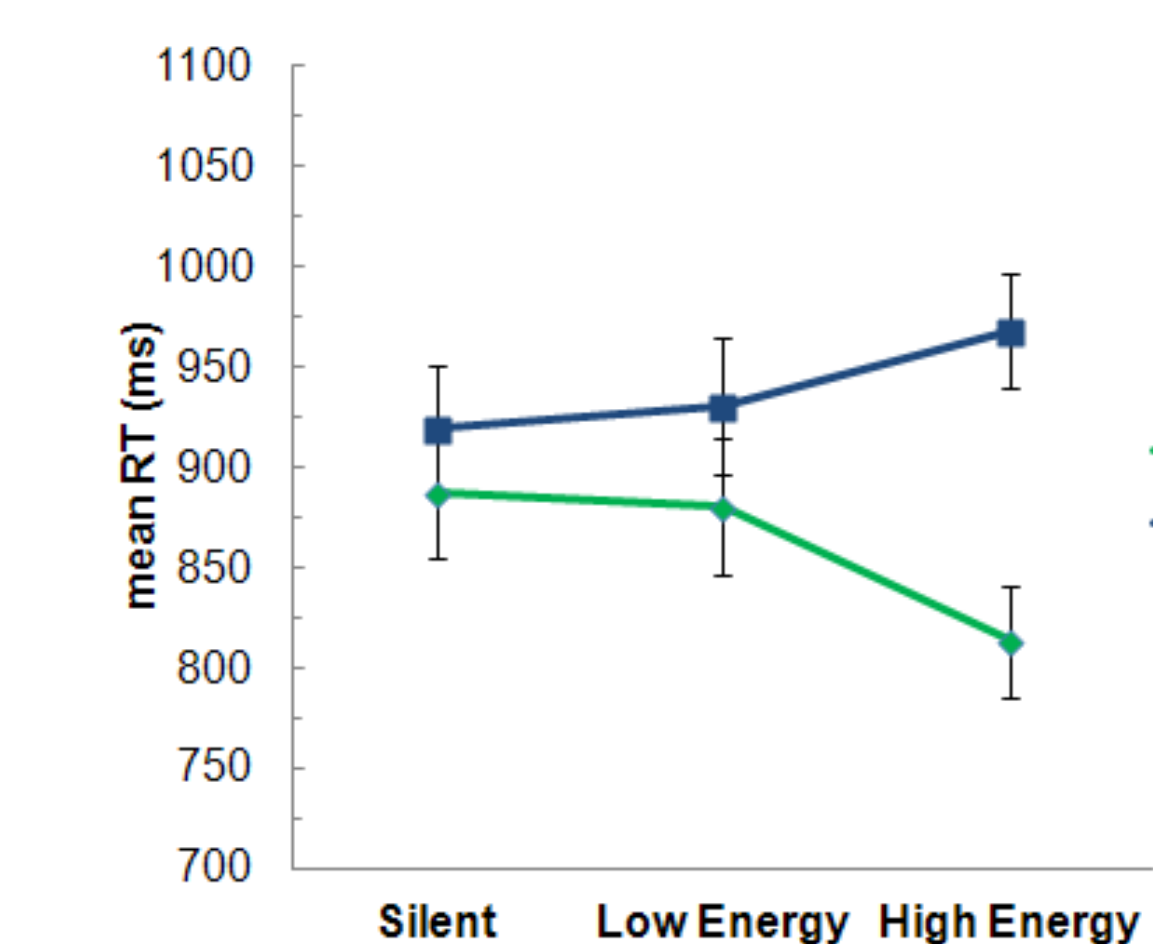**EC**: Only High Energy Music improved fluency
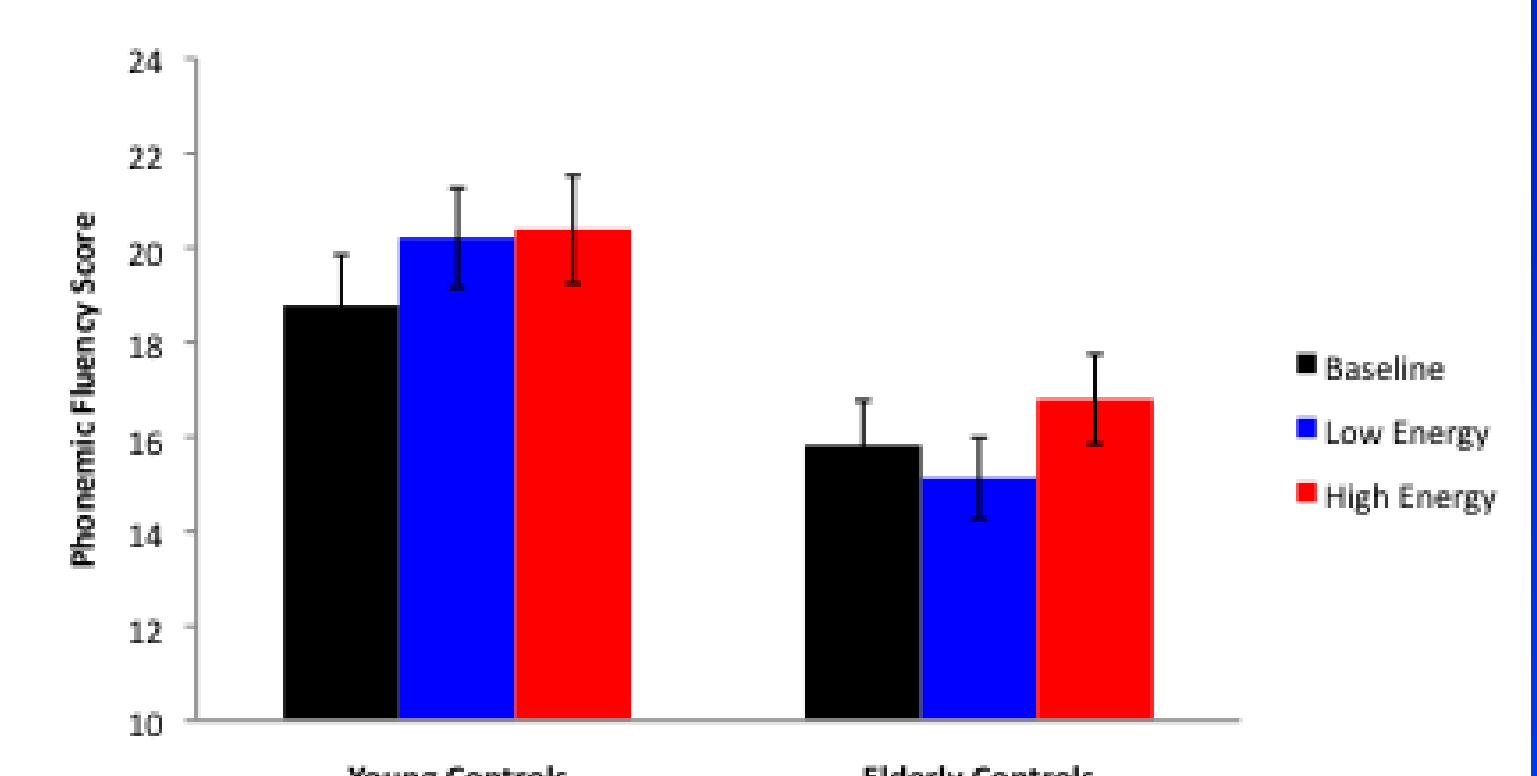
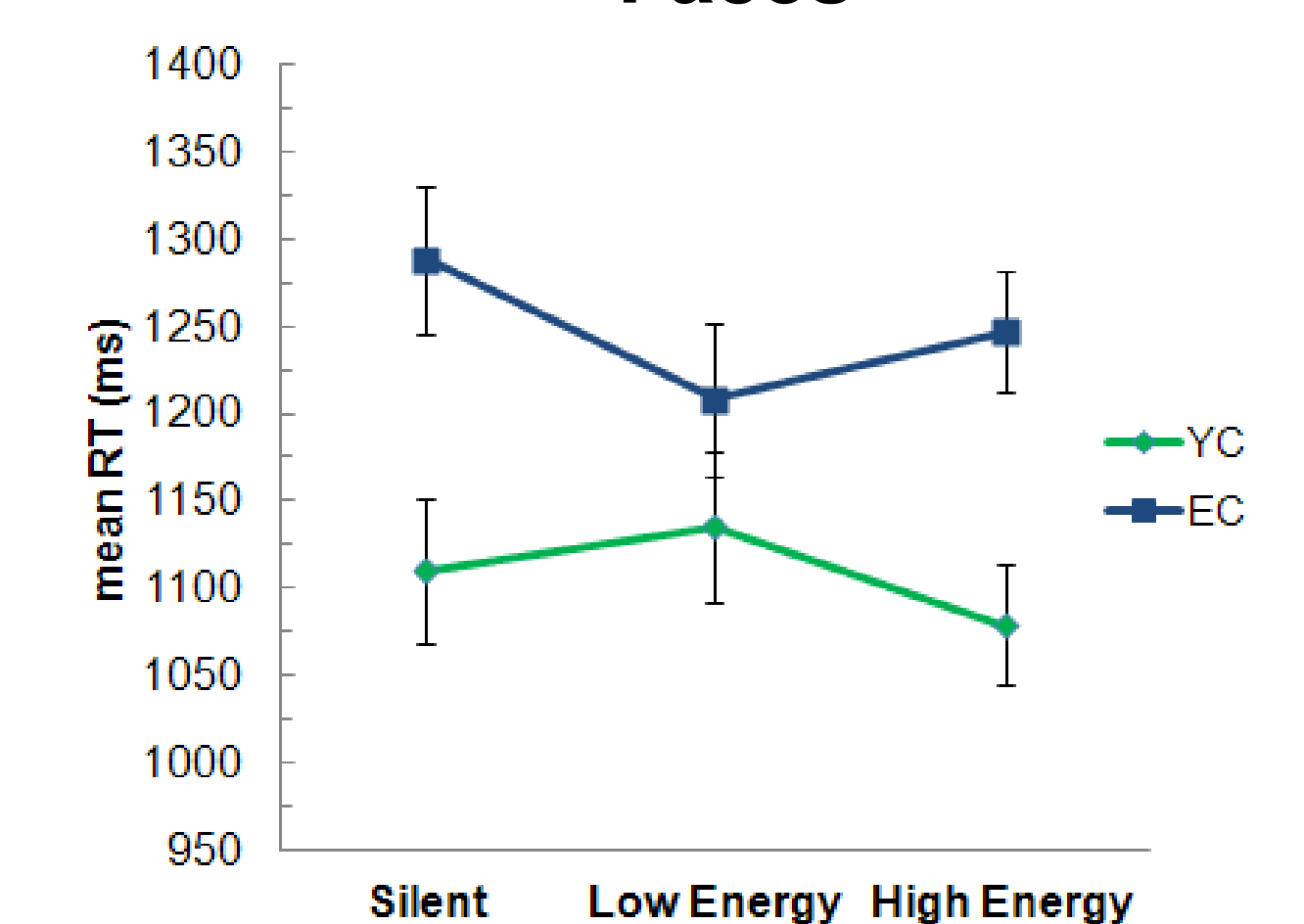## Recognition Memory

Study Phase: 20 nouns or non-famous faces
Recognition Phase: 40 nouns or non-famous face
  - 20 previously studied and 20 new
  - Respond whether each stimulus is 'Old' or 'New'

Words

Faces

Recognition Memory Reaction Times: Overall faster RTs for YC than EC group
Words – Significant *Grp x Music Condition Interaction* : High Energy Music significantly decreased RTs in YC group, but increased RTs in EC group
Faces – Marginally significant *Grp x Music Condition Interaction* : same pattern as word task

Conclusions

Our study expands the existing literature that suggests music can induce specific changes in mood and arousal which also impacts cognitive function. Furthermore, music's effects on cognition depends on multiple factors:

1. **The cognitive function being examined and task chosen to assess that function:**
   - Music did not affect Digit Span performance, or accuracy in the Attention or Recognition Memory tasks.
   - Music *did* affect Phonemic Fluency Scores and Reaction times in the Attention and Recognition Memory tasks.

2. **Participants' age:**
   For Phonemic Fluency:
   - YC group performance improved under both Low and High Energy whereas
   - EC group performance improved only under High Energy Music conditions

   For Alerting/Orienting and Recognition Memory:
   - High Energy Music conditions decreased RTs in the YC group whereas
   - Low Energy Music conditions decreased RTs in the EC group