



Christian Stilp



Isabel Adames

# Multiple timescales of context shape the perceptual sensitivity to natural pairings of musical pitch and timbre



Anya Shorey



## Introduction

Musical pitch and timbre perceptually interfere with each other (Melara & Marks 1990; Krumhansl & Iverson 1992; Pitt 1994)

Perception is aided when pitch and timbre covary: lower pitches with darker timbres, higher pitches with brighter timbres (Allen & Oxenham 2014; McPherson & McDermott 2023)

How do different timescales of context influence this sensitivity to pitch-timbre covariance?

- Block level
- Session level (block ordering / testing formats)
- Long-term (musical background)

Pitch labeling is predicted to be more accurate when:

- Pitch and timbre are presented consistent with their common pairings (lower pitch + darker timbre, higher pitch + brighter timbre) than their less-common pairings
- Listeners have more musical training

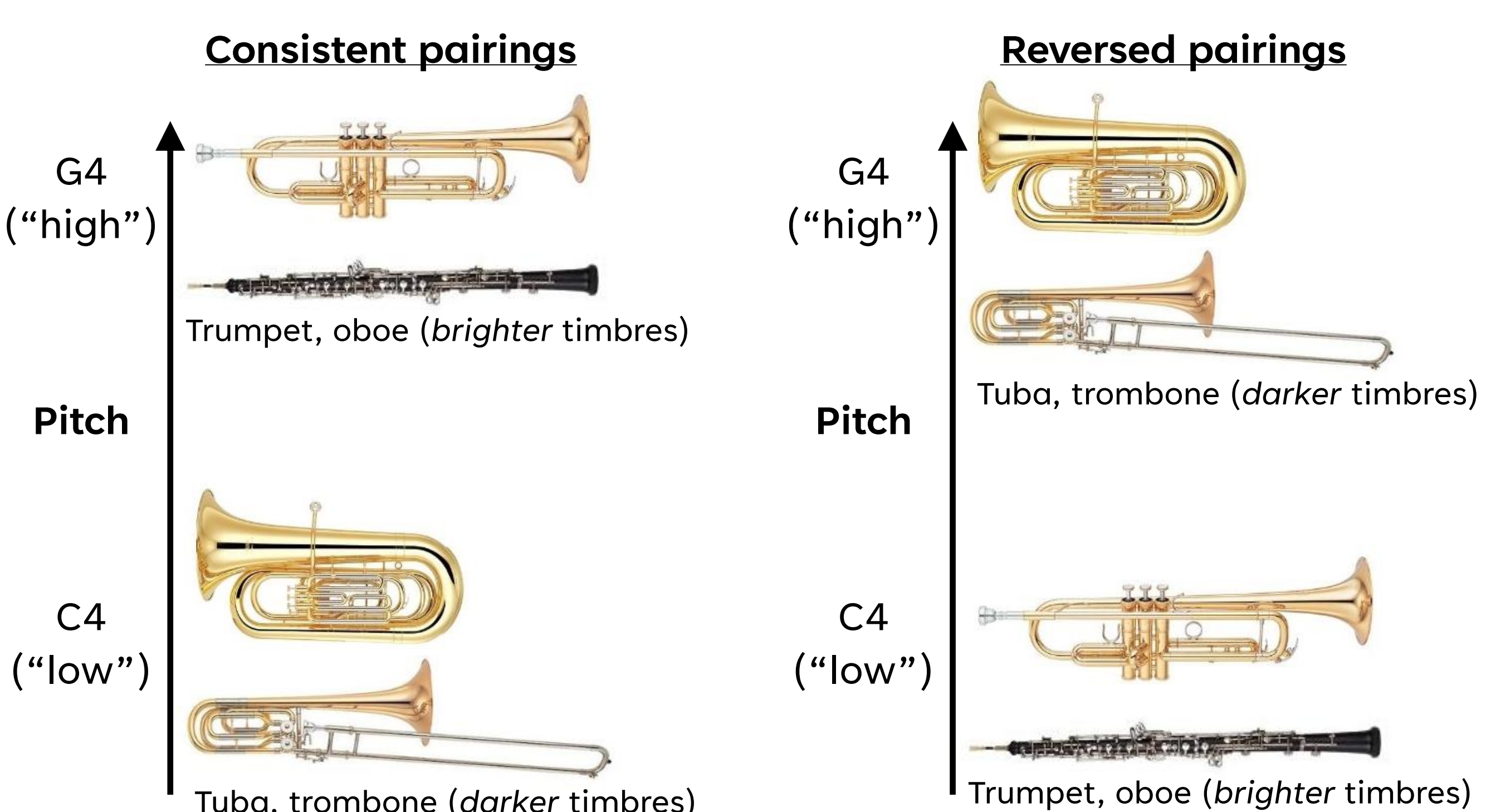
## Method

### Participants

Four undergraduate samples (each n = 39-44) of normal-hearing listeners with variable musical backgrounds

### Stimuli

1-second recordings of instruments playing C4 and G4



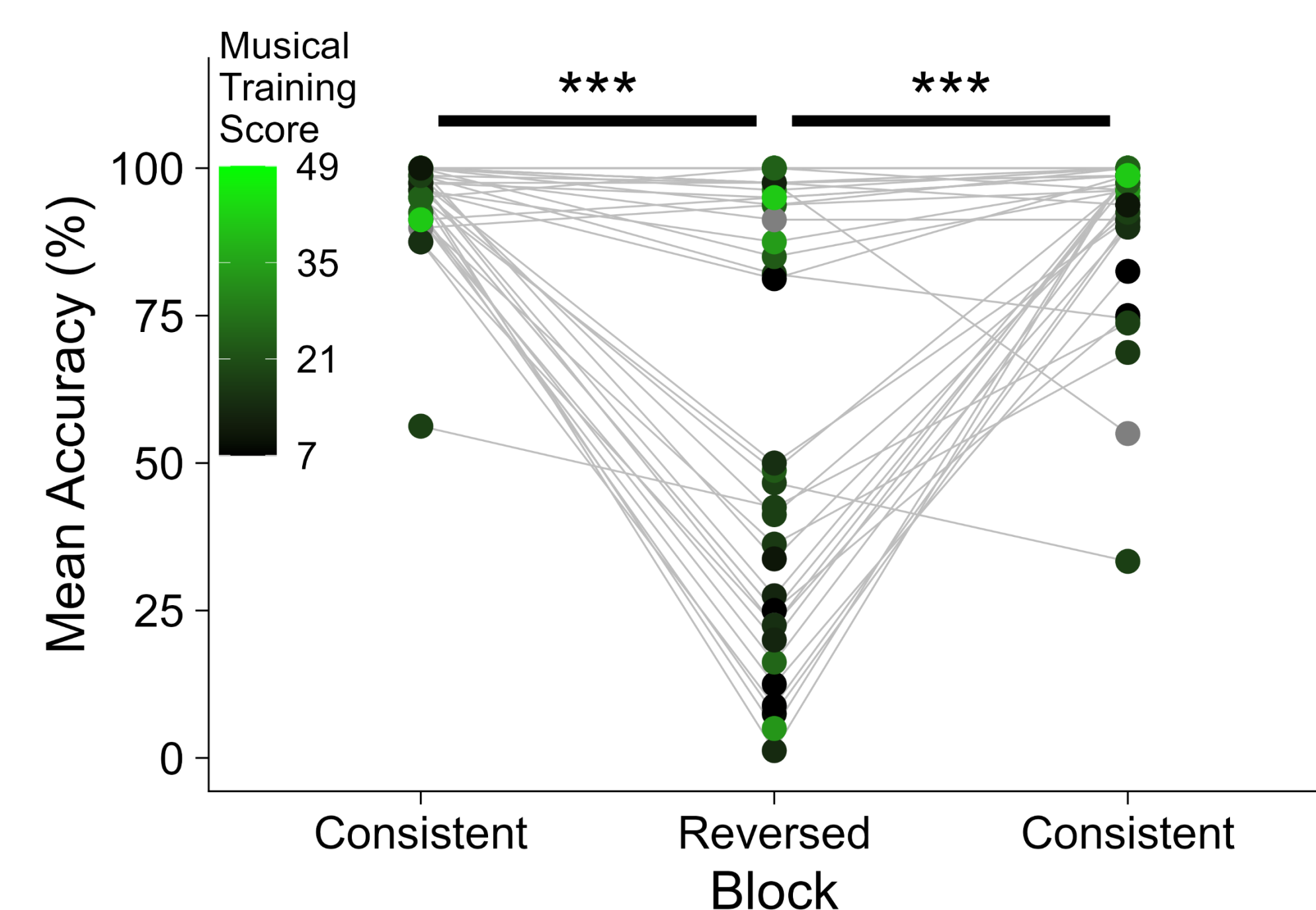
### Procedure

Consent, headphone screen, brief practice with feedback  
3 blocks of 80 trials: label the tone pitch as “low” or “high”  
Gold-MSI musical training questions (Müllensiefen et al. 2014)

## Results

### Expt. 1

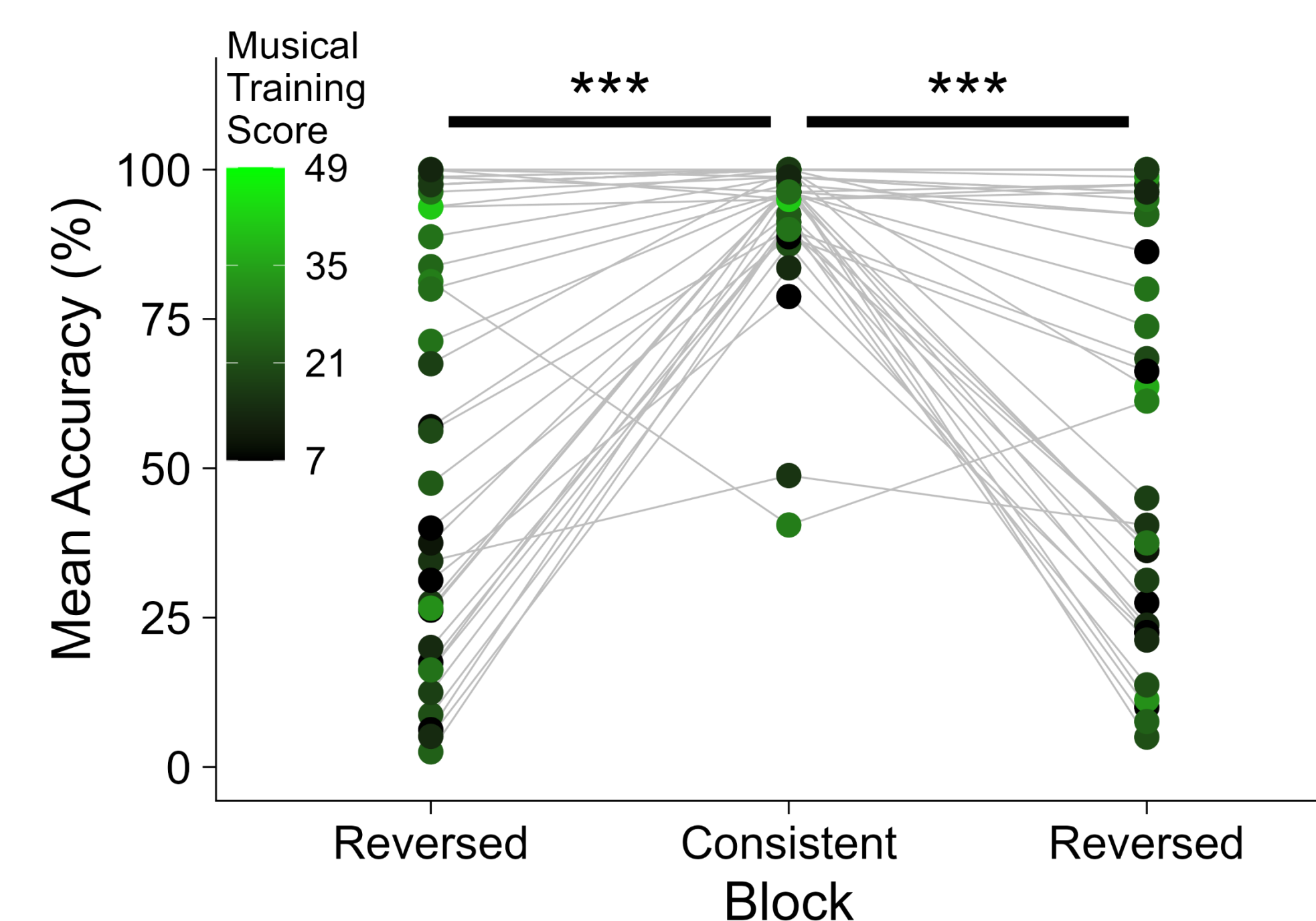
How much does pitch labeling depend on pitch-timbre pairings?



- Superior performance in Consistent blocks, many pitch-timbre confusions in Reversed block
- Musical training (dot color) is positively associated with accuracy in every block

### Expt. 2: Block order rearranged

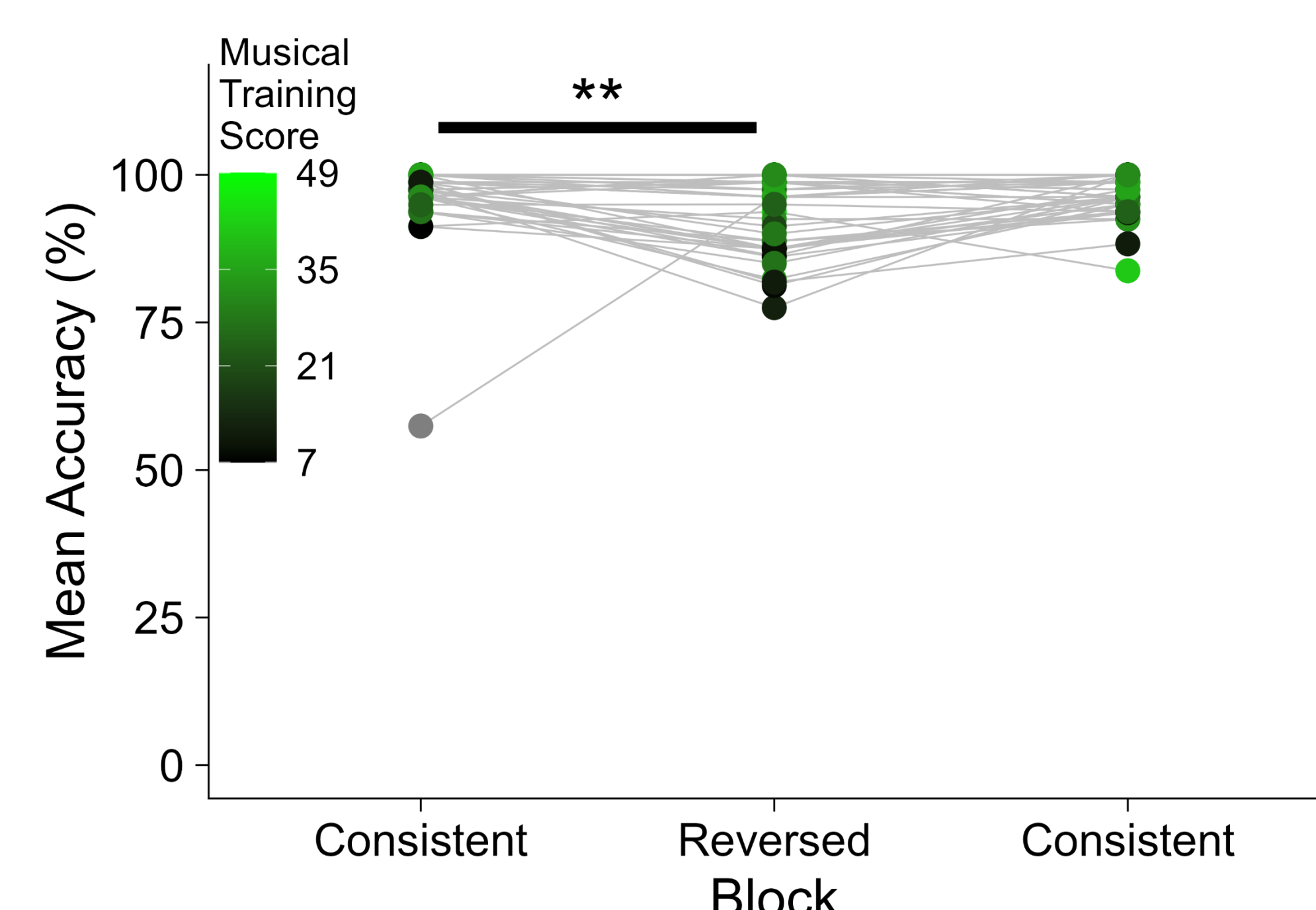
Do patterns of performance follow the stimuli when they are tested in a different order?



- Performance flipped, tracking stimulus statistics closely
- Musical training again positively associated with accuracy in every block

### Expt. 3: Feedback

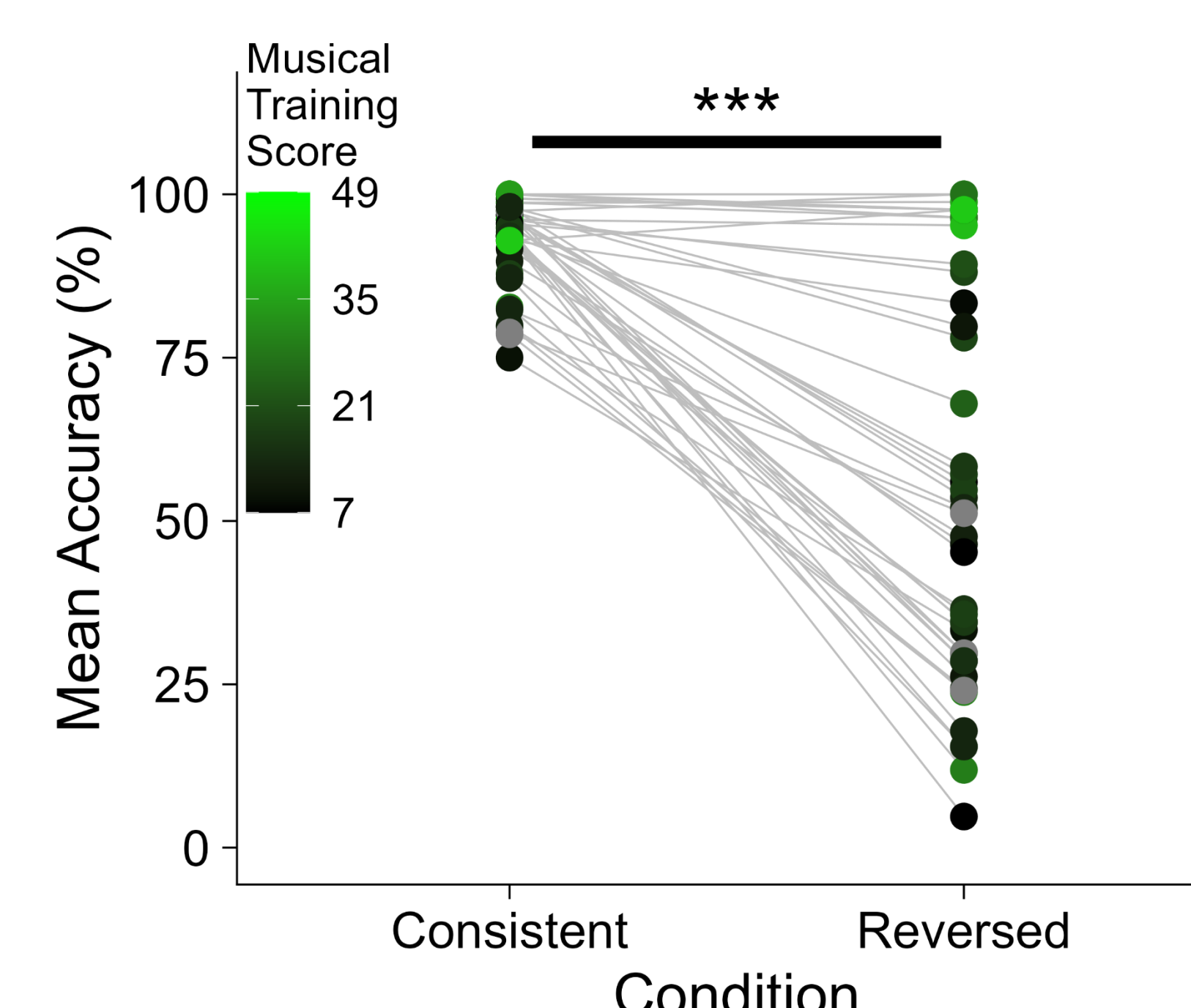
Will feedback on each trial allow listeners to correct pitch-timbre confusions, improving performance on Reversed trials?



- Reversed accuracy dramatically improved relative to Expt. 1
- Musical training only associated with accuracy on Reversed trials

### Expt. 4: Interleaved testing

Does blocking stimuli inflate performance relative to interleaving stimuli (as we encounter these sounds in everyday listening)?



- Accuracy not significantly lower than in Expt. 1
- Musical training is positively associated with accuracy for both trial types

## Discussion

Musical pitch was labeled more accurately amidst common pairings with timbre than amidst less-common pairings. This sensitivity was shaped by various timescales of context:

- Block contents
- Block testing order
- Blocked vs. interleaved testing
- Musical training

Response time data (not shown) complements accuracy

- True effects: RTs were faster for Consistent sounds in Expt. 4 (interleaved) and Expt. 2 (when tested second)
- Practice effects: in Expts. 1-3, RTs were fastest in Block 3 (which repeated Block 1 stimuli)

Trial-by-trial context also contributed

- Throughout, accuracy improved trial-by-trial for Reversed trials but was largely flat for Consistent trials
- RTs decreased throughout each block, but to lesser degrees as the experiment progressed
- In Expt. 4, RTs decreased more quickly for Reversed trials

Pitch-timbre interference and/or covariance maintain across widely varying pitches, pitch intervals, instruments, and tasks; but, it is not universal (McAdams et al. 2023)

Perceptual benefits of musical training are more local (every Reversed condition) than global (Consistent conditions in Expts. 1, 2, 4), but the link is not causal. Future approaches should view musical background more broadly (i.e., general musical sophistication).

## References

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Krumhansl, C. L., & Iverson, P. (1992). *JEP:HPP*, 18(3), 739-751.

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Müllensiefen, D., Gingras, B., Musil, J., & Stewart, L. (2014) *PLoS One*, 9(2), e89642.

Pitt, M.A. (1994). *JEP:HPP*, 20(5), 976-986.