



# Amplitude Envelope and Intentionality

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## Background

- Musical reward is tied to predictable structural acoustic, melodic, and rhythmic features.
- Listeners have preferences for isolated, non-referential sounds that do not rely on these higher-level musical features.
- At the same time, recent work has suggested that the investigation of the source of music is an understudied domain in understanding pleasurable music listening experiences.
- Lower-level acoustic features, such as amplitude envelope, may elicit musical preferences. Here we investigated one possibility of why certain amplitude envelopes might be preferred over others: the perception of sound source.

**Hypothesis:** Listeners use low-level auditory features, such as timbre and amplitude modulation, to discern the source of a given sound. As such, sounds with noisy timbres will be perceived as less intentional, and sounds with greater amplitude modulation will be perceived as more intentional.

## Methods

### Study 1:

41 undergraduate participants listened to 40 500ms sounds and rated them on their subjective intentionality. These participants also completed our battery of psychometric surveys:

- Extended Barcelona Musical Reward Questionnaire (*eBMRQ*), containing all five subscales (emotional response, mood regulation, sensorimotor, music-seeking, and social reward) with the additional Absorption subscale. This measures participants' musical reward sensitivity.
- Goldsmith's Musical Sophistication Index (*Gold-MSI*), a measure of musical training and musical engagement.

### Study 2:

87 undergraduate participants completed the same task, but with 3000ms tones. They completed a larger battery of psychometric surveys:

- *eBMRQ*; *Gold-MSI*
- Musical Ear Test (*MET*), a test of melodic and rhythmic perception
- Physical Anhedonia Scale (*PAS*), a measure of pleasurable response to physical stimuli.

## Stimuli

### Study 1:

Using 500ms tones, we varied attack time and timbre.

- *Attack Times*: 1ms, 5ms, 30ms, 100ms, 200ms, 300ms, 499ms.
- *Timbres*: white noise, triangle, sine, saw, and square.

All tonal sounds were played at 220Hz. All sounds were generated and amplitude-normalized using Max-MSP. Each participant was also presented with a random selection of 40 sounds drawn from the IADS 165 emotional sounds database.

### Study 2:

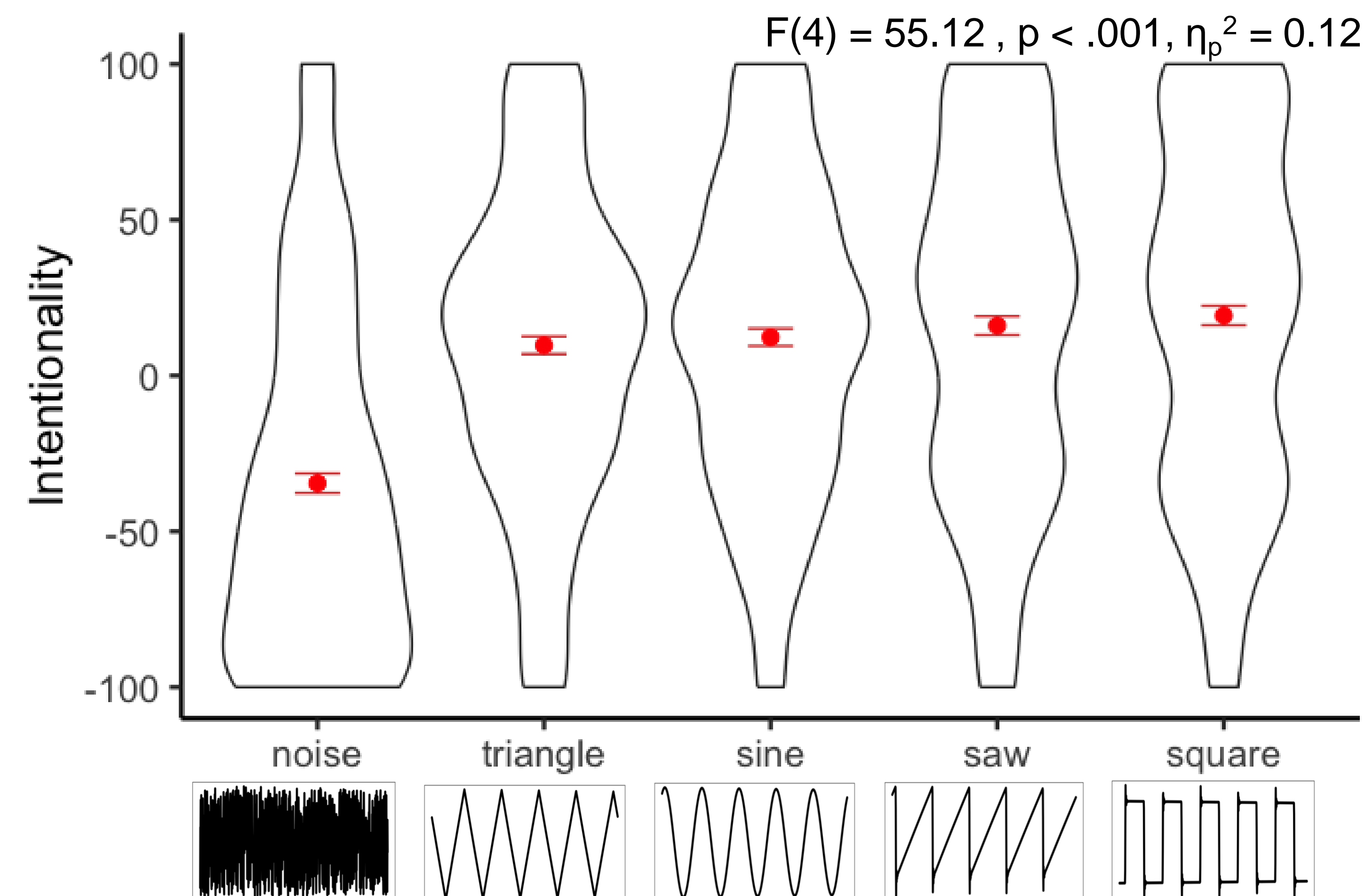
Using 3000ms tones, we varied attack time, timbre, frequency, warble frequency, and warble depth.

- *Attack Times*: 187ms, 1500ms.
- *Timbres*: saw, sine.
- *Frequency*: 220Hz, 1000Hz.
- *Warble Frequency*: no warble, 1.5Hz, 3Hz, 6Hz.
- *Warble Depth*: no warble, shallow warble (50% amplitude reduction), deep warble (100% amplitude reduction).

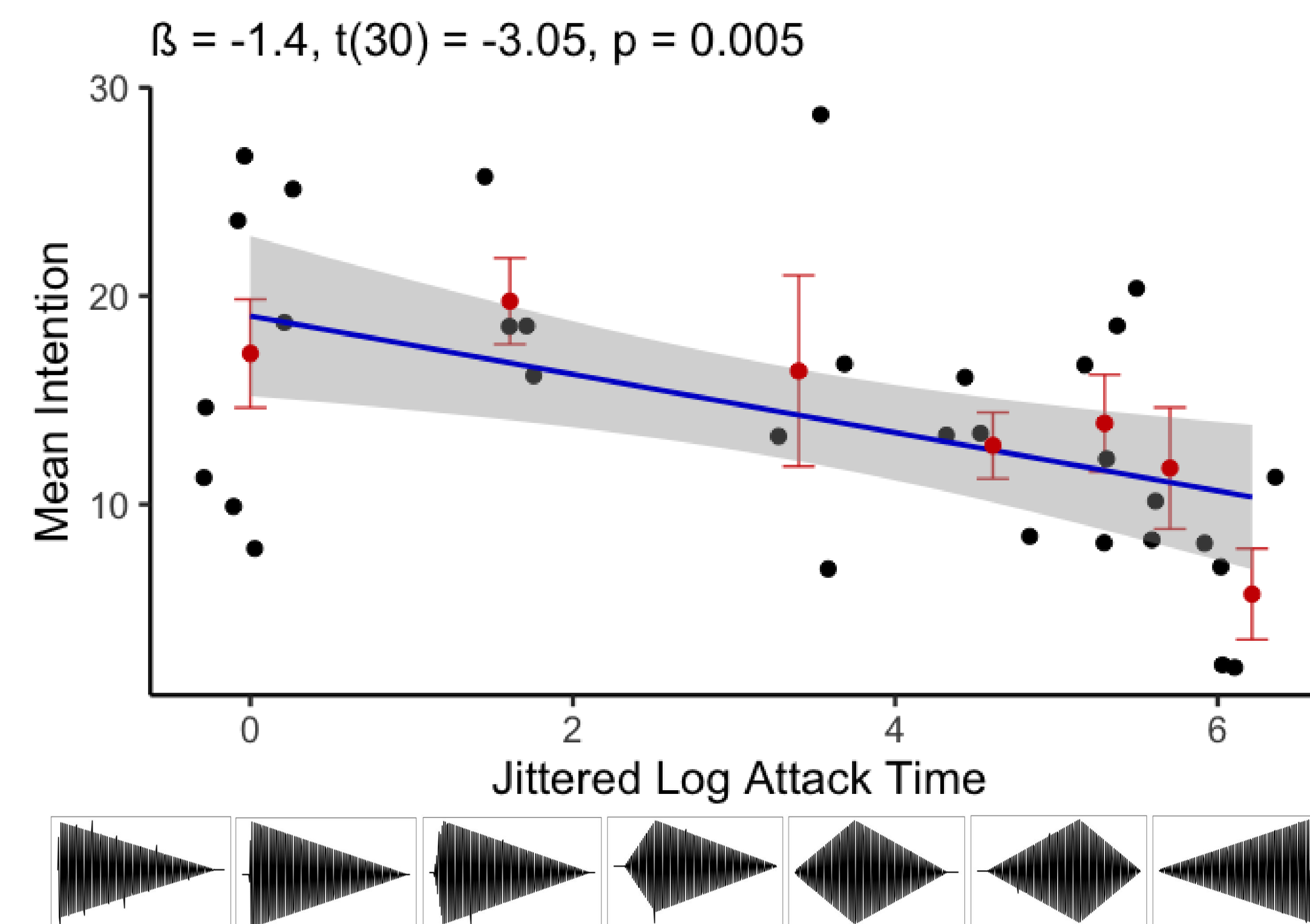
Sounds were generated and loudness-normalized in Python using `scipy.signal`, `numpy`, and `pyloudnorm`.

## Study 1: 500ms Tones

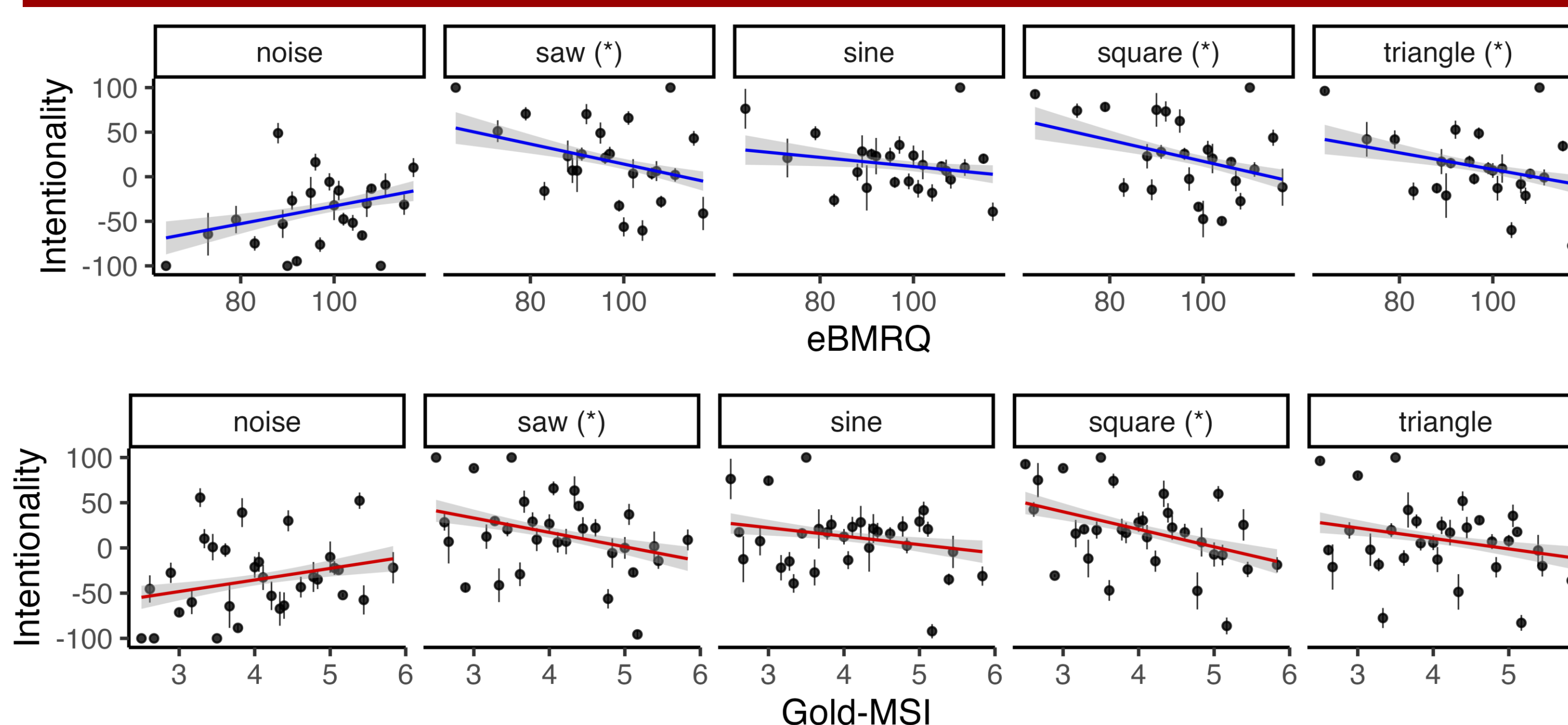
### Timbre Relates to Intentionality



### Attack Time is Negatively Related to Intent

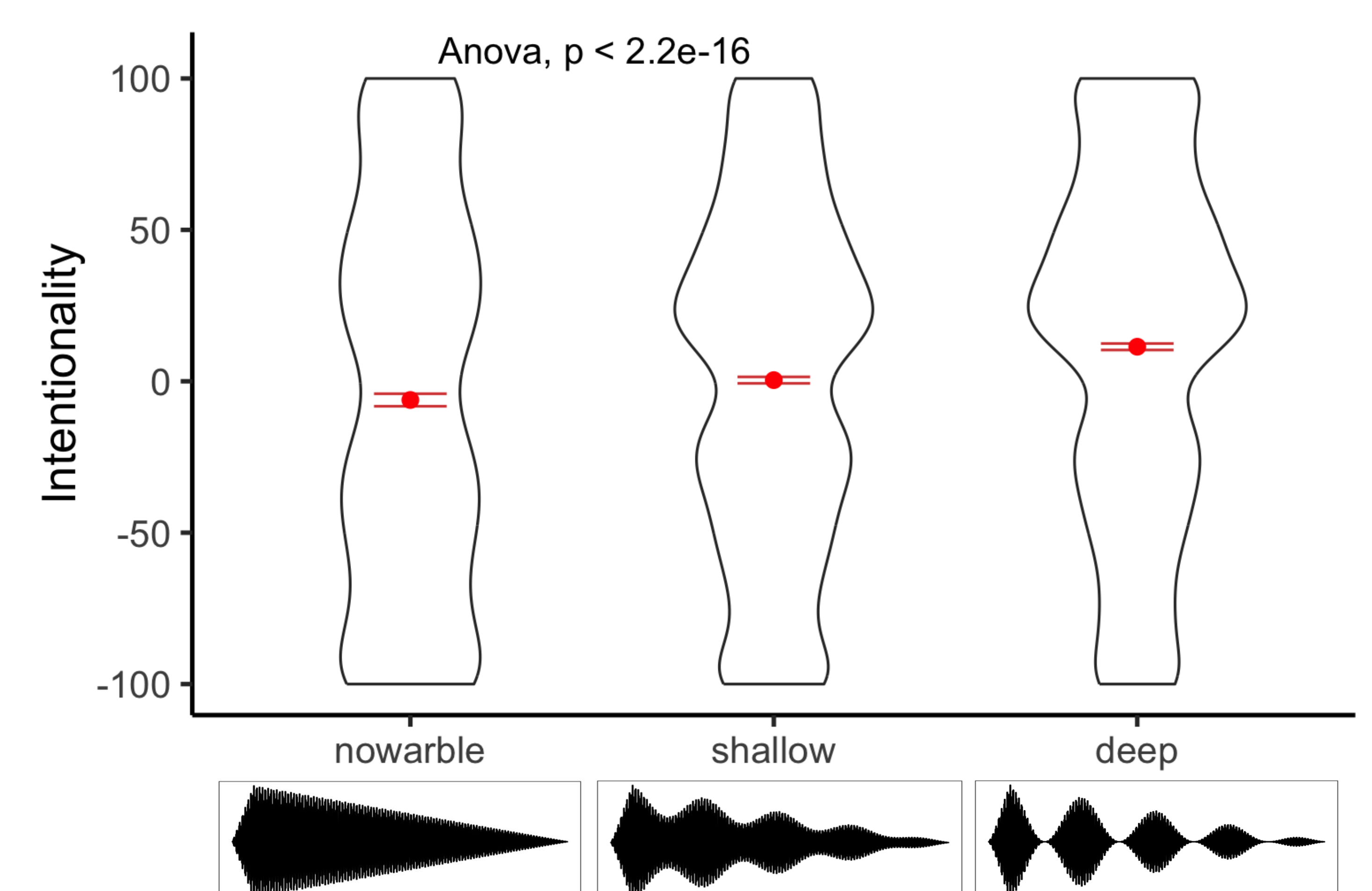


### eBMRQ and Gold-MSI Negatively Related to Intent For Specific Timbres

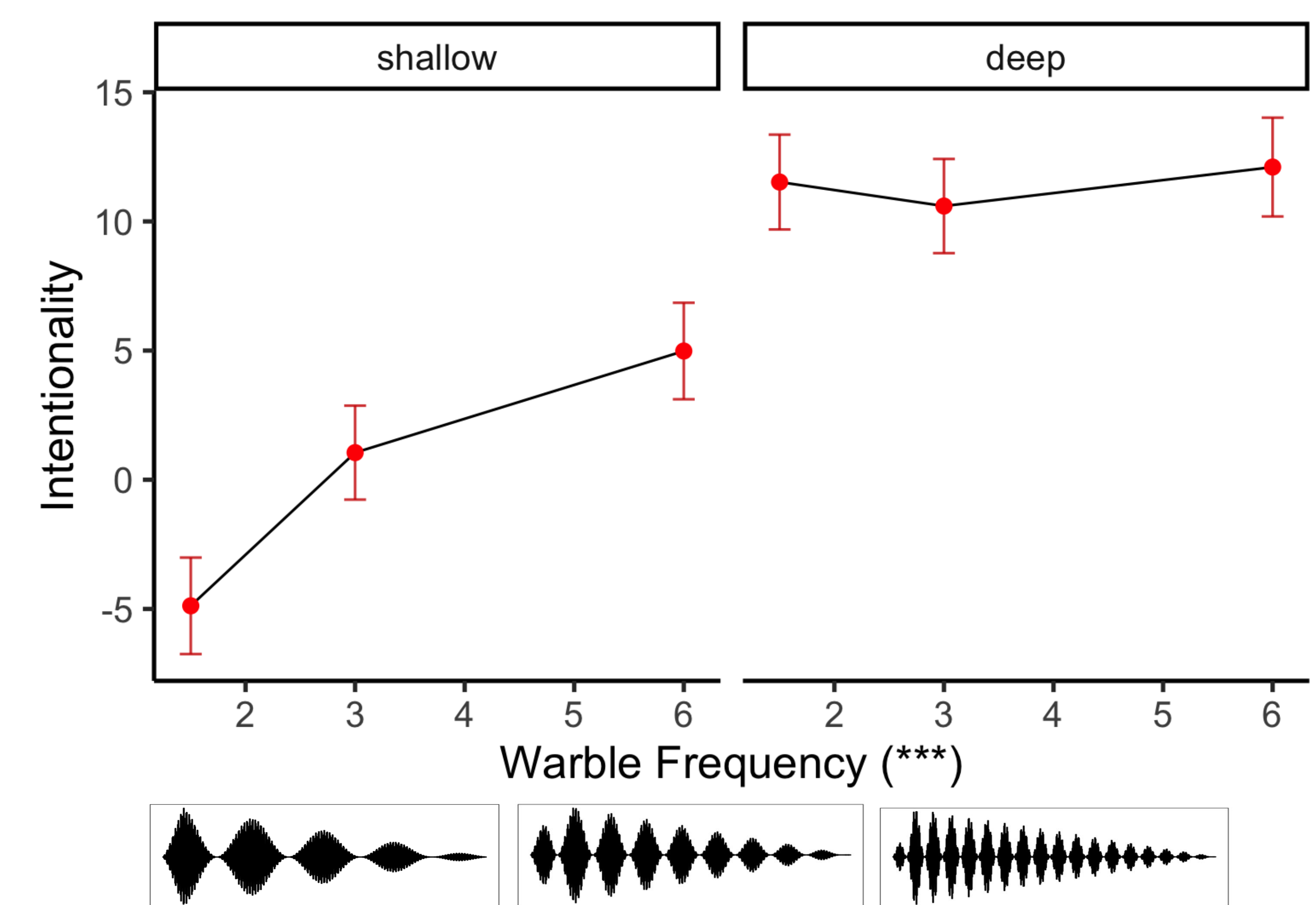


## Study 2: 3000ms Tones

### Warble Depth (AM) Predicts Intent



### Warble Frequency Predicts Intent



## Discussion

- Noisy Timbre is significantly less intentional than other timbres.
- Participants' musical reward sensitivity and musical sophistication decrease ratings of intentionality
- Increased Amplitude Modulation (attack time, warble depth, warble frequency) increases ratings of intentionality.

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