# Perceived Intentionality of Amplitude Envelopes

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## Background

- Musical appreciation involves source sensitivity – identifying and engaging with causes of music making (Thompson et. al, 2023).
- Listeners have preferences for isolated, non-referential sounds even when they cannot explicitly identify the sources of these sounds (Kathios et. al, 2023).
- Lower-level acoustic features, such as amplitude envelope, may elicit musical preferences (Kathios et al, 2023).
- Here we investigated one possibility of why certain amplitude envelopes might be preferred over others: the perception of intentionality.

**Hypothesis:** Listeners use low-level auditory features, such as timbre and amplitude modulation, as cues for the intentionality of sounds. 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 (19F, $age_{mean}$ = 18) undergraduate participants listened to 40 500ms sounds and rated them on their perceived 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 (Mas-Herrero et al, 2013; Cardona et al, 2022).
- Goldsmith's Musical Sophistication Index (*Gold-MSI*), a measure of musical training and musical engagement (Müllensiefen et al, 2014).

**Study 2:**

80 (64F, $age_{mean}$ = 19) 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 (Wallentin et al, 2010).
- Physical Anhedonia Scale (*PAS*), a measure of pleasurable response to physical stimuli (Chapman, 1976).

## 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:**

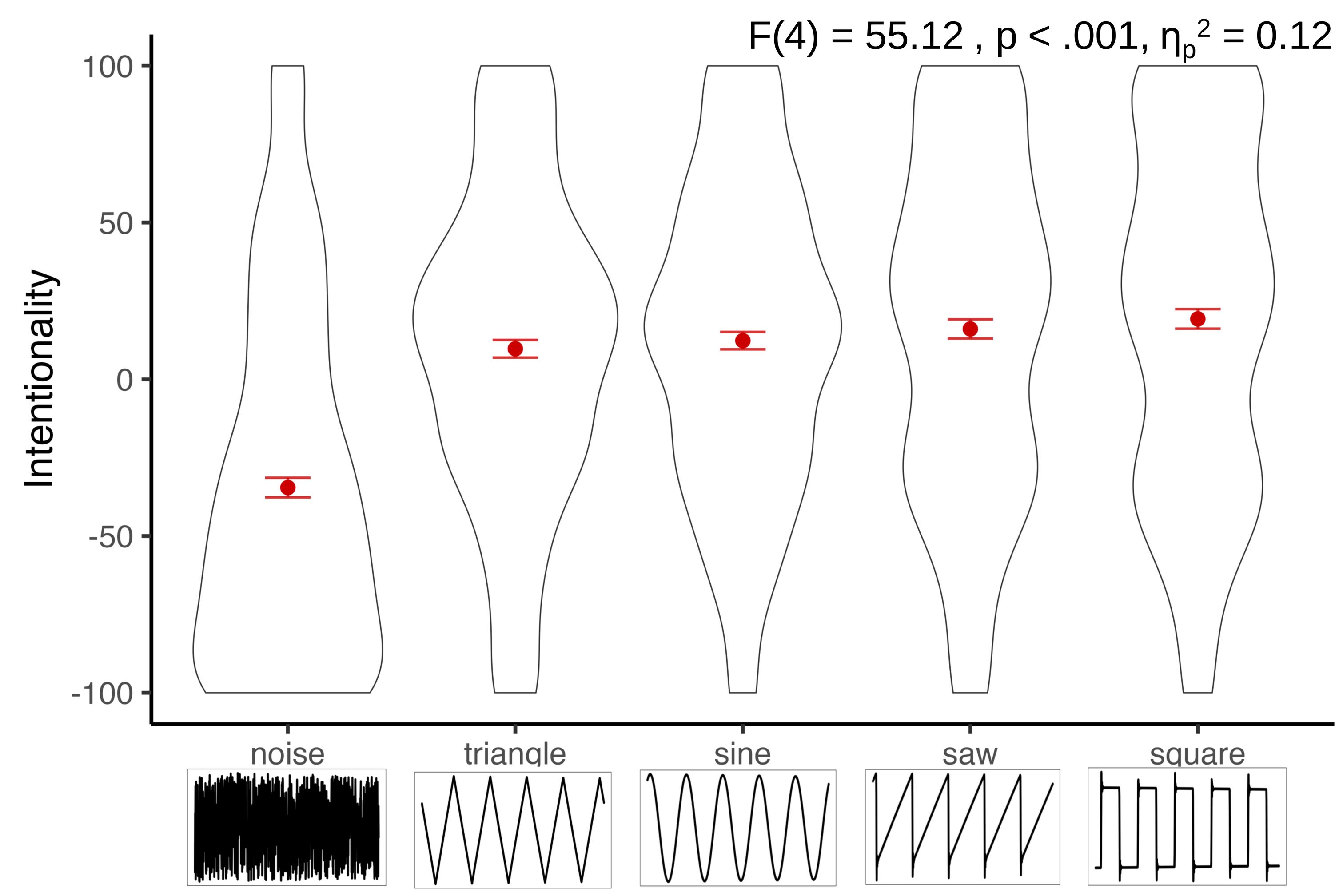
Using 3000ms tones, we varied attack time, timbre, frequency, warble frequency, and warble depth.

- *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).

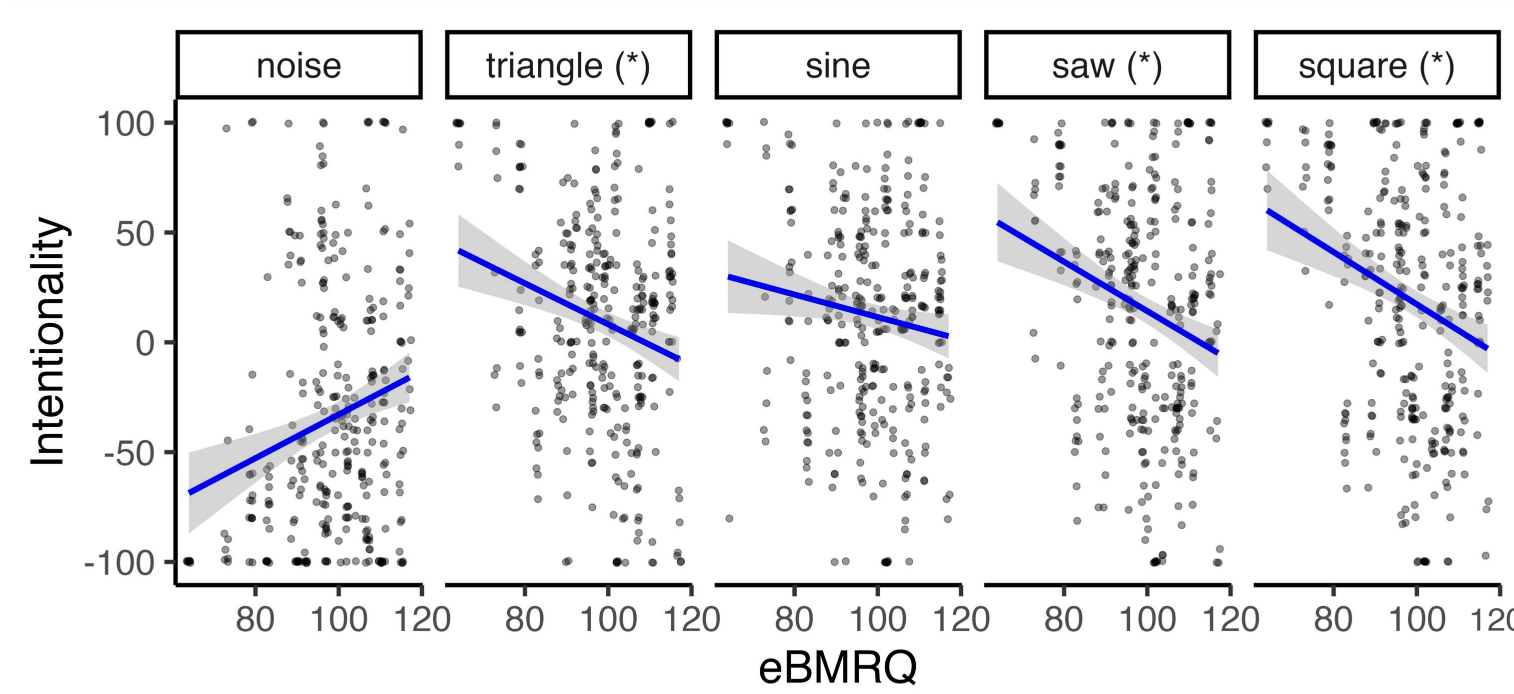
Sounds were generated and loudness-normalized in Python using scipy.signal, numpy, and pyloudnorm.

## Study 1: 500ms Tones

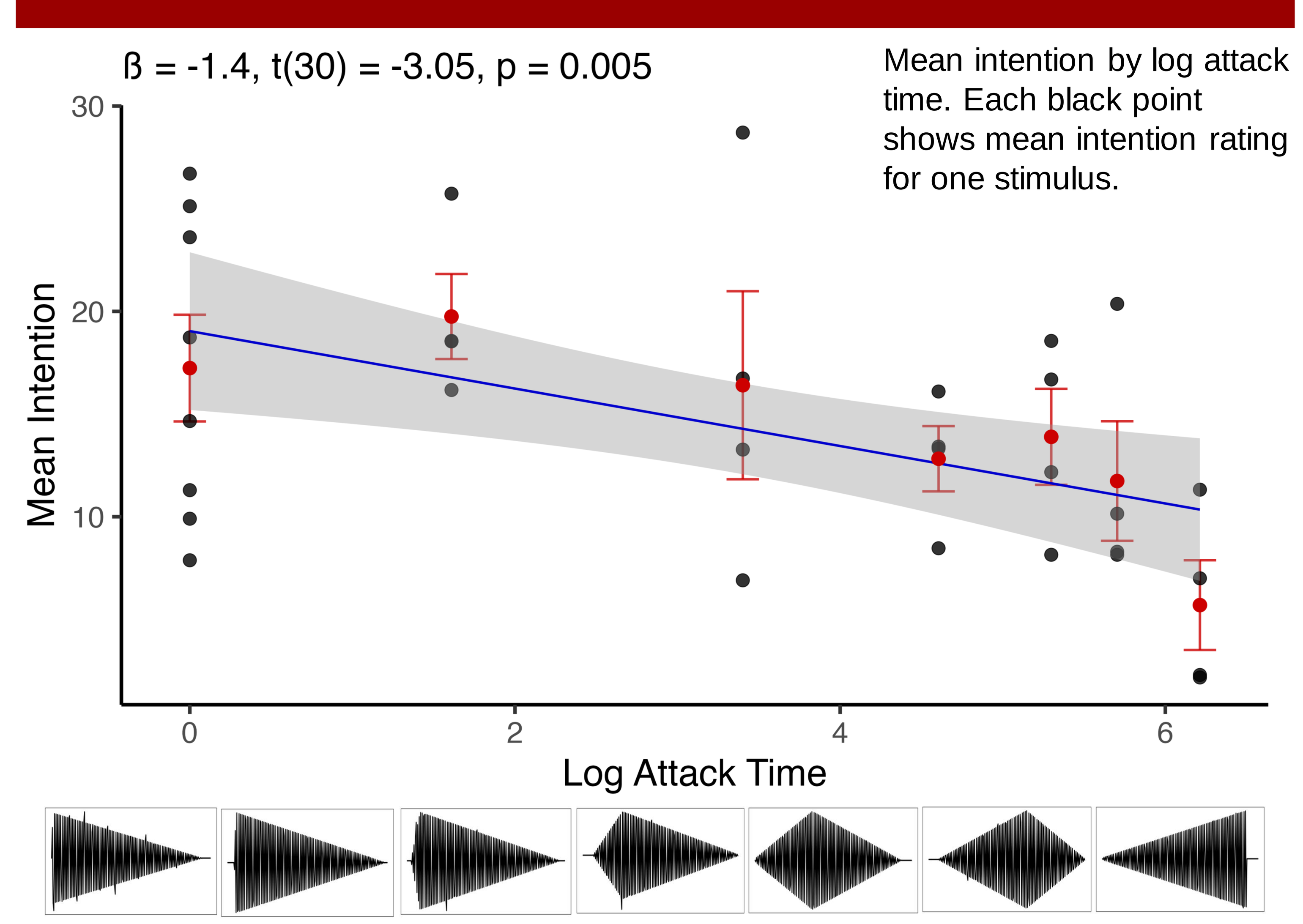
### Noise is Rated as Least Intentional




### eBMRQ is Negatively Related to Perceived Intentionality For Periodic Timbres

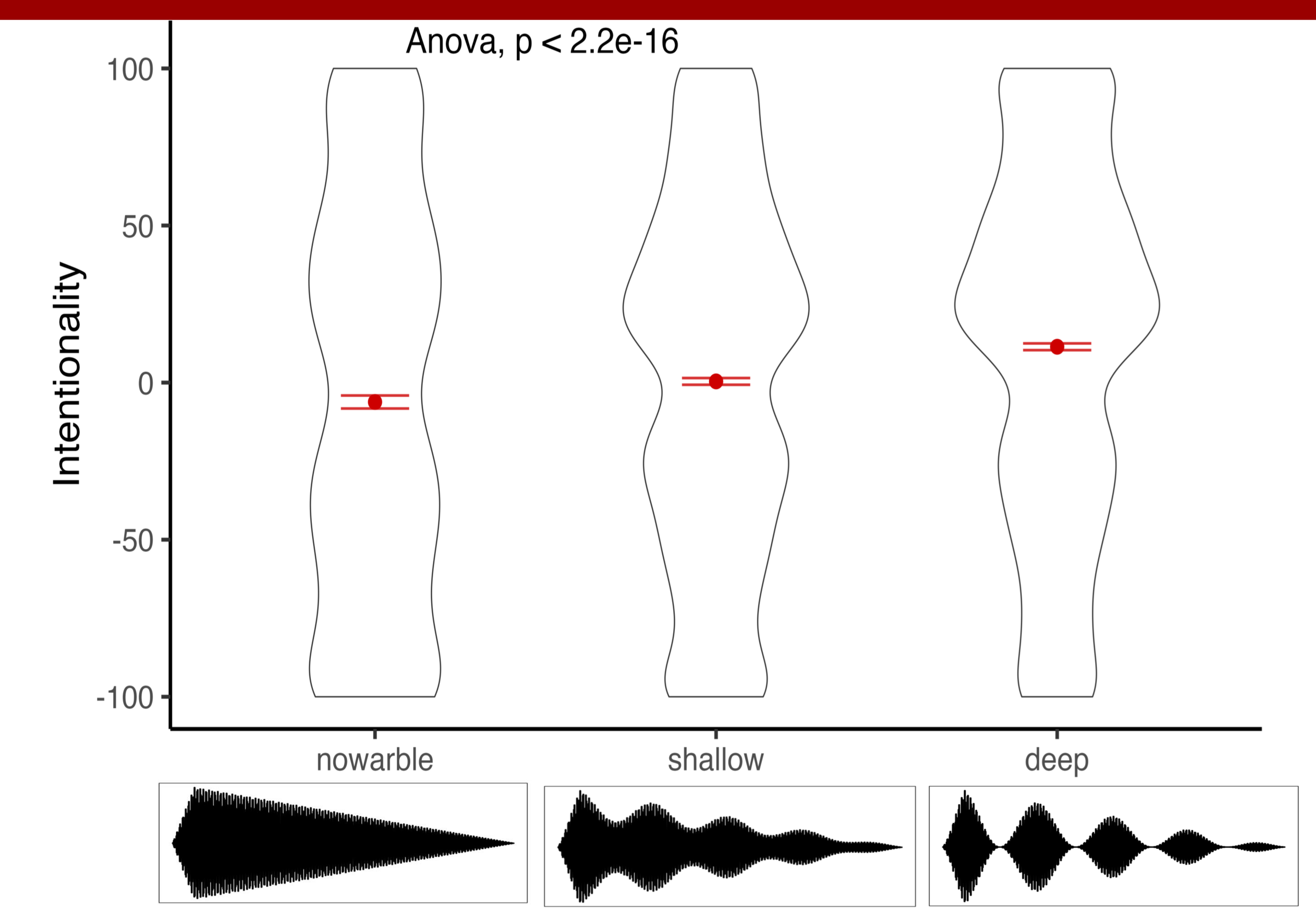



### Attack Time is Negatively Related to Perceived Intentionality

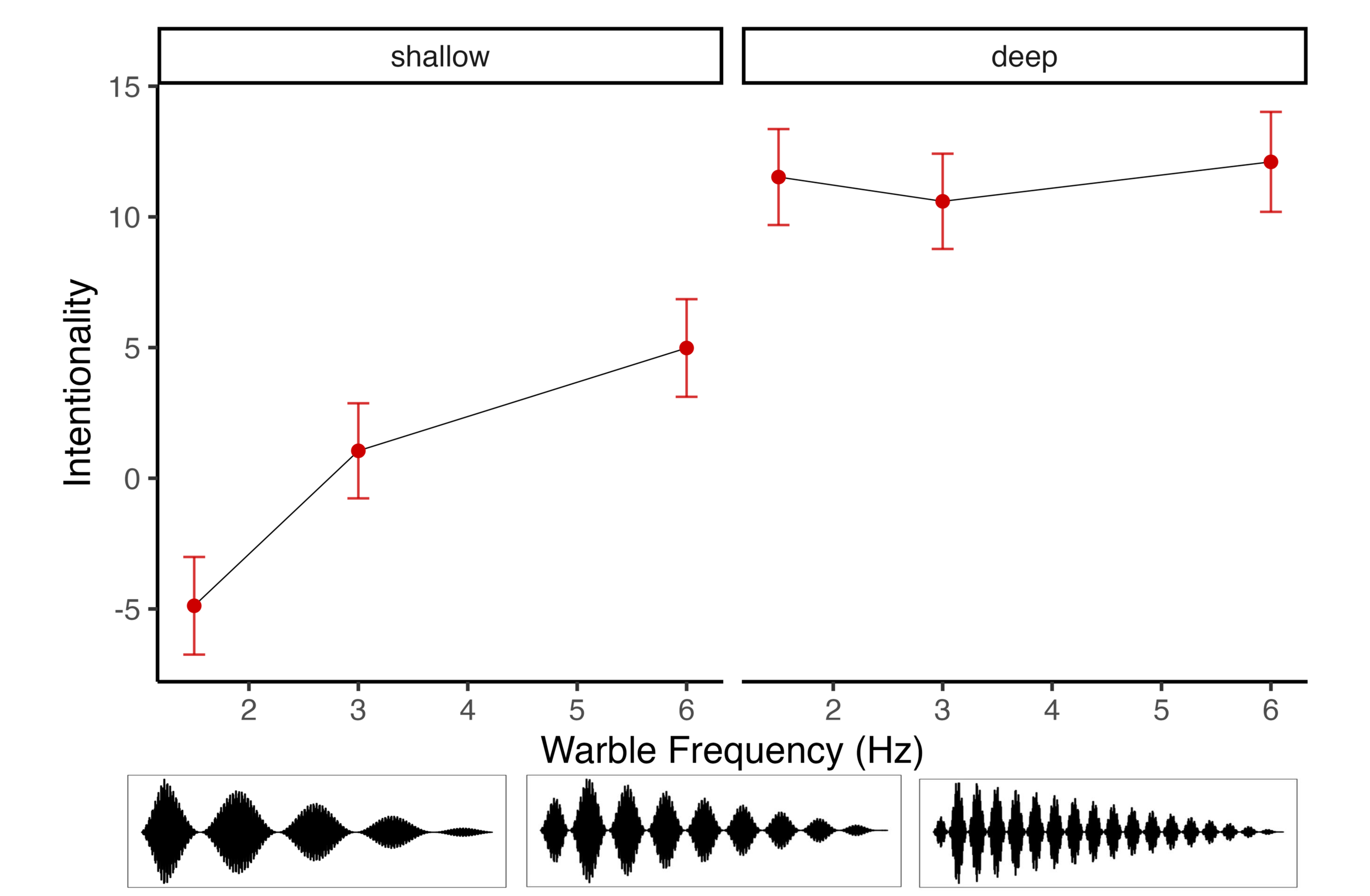



## Study 2: 3000ms Tones

### Warbles Increase Perceived Intentionality




### The Effect of Warble Frequency (Hz) Interacts With Warble Depth




## Discussion

- White noise was rated as the least intentional timbre, suggesting that the periodicity of sounds may contain information that listeners use to determine sound source.
- Periodicity may also account for the effects of higher-level amplitude modulation, as shown in the interaction between Warble Frequency and Warble Depth.
- Participants with high musical reward sensitivity show lower intentionality ratings for periodic sounds, suggesting that they have higher internal thresholds for what constitutes an intentional sound.
- Future Study: Two Alternative Forced Choice to elucidate the relative intentionality of two sounds.

## References

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