Neural entrainment to synchronous and asynchronous observed human movement

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Background

People tend to **synchronize** their behavior **with the group** (e.g. Dyer et al., 2009)

Both moving in synchrony and observing such synchronous behavior is **rewarding** (e.g., Zimmermann et al., 2018; Vicary et al., 2017)

Synchrony is also principle of **perceptual organization** (Wagemans et al., 2012) and has **top-down influence** on visual processing (Alp et al., 2017)

But how is synchrony processed in the brain?

Hypothesis

The brain binds together individual movements into **configural group representations** based on the relationships among them → increased **neural entrainment for synchronous movements**

Methods
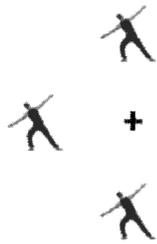
Synchrony   Asynchrony

Subjects watch 4 dancers move **in/out of sync**:
→**Exp 1 (N = 19)**: Fluent or non-fluent movements
→**Exp 2 (N = 19)**: Upright or inverted dancers

EEG frequency tagging to measure:
→**Base rate response** = image presentation
→**Half cycle response** = movement repetition
→**Full cycle response** = body posture repetition
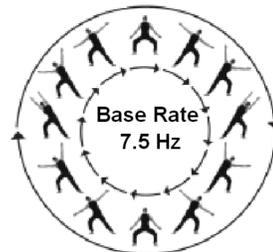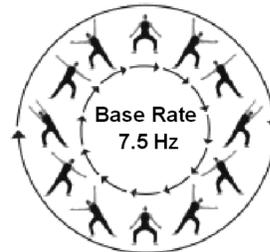
Fluent (Exp 1 + 2)   **Non-Fluent** (Exp 1)   **Inverted** (Exp 2)

Half Cycle 7.5/6 Hz

Base Rate 7.5 Hz
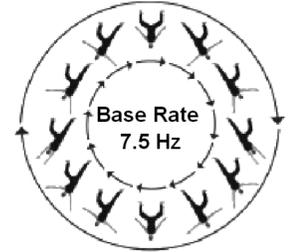
Full Cycle 7.5/12 Hz

EEG Spectrum
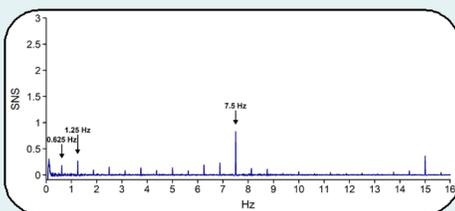
Half Cycle Sync Effect

Exp 1   F   NF

Exp 2   UP   INV
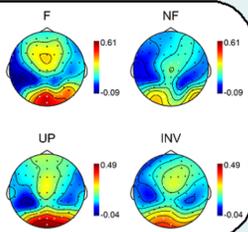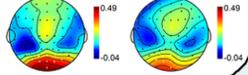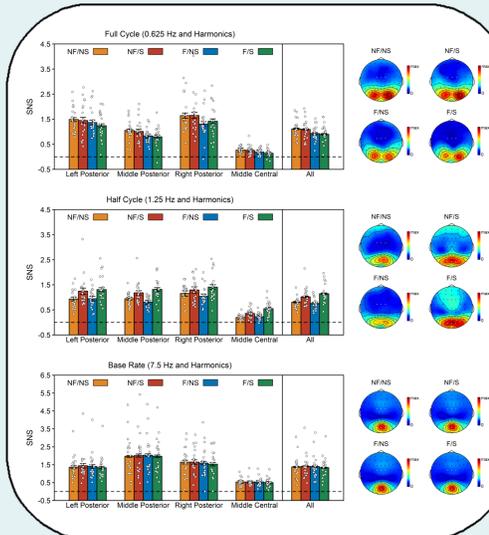
Experiment 1

1. **Fluency (***)**: NF > F (d = 1.61)
2. **Region (***)**: Lat > mid (η_p^2 = 0.77)

1. **Sync (***)**: S > NS (d = 1.33)
2. **Sync x Fluency (**)**: S > NS ⇧ for F (d = 0.62)
3. **Region (***)**: Post > cent (η_p^2 = 0.81)

1. **Region (***)**: Mid > lat (η_p^2 = 0.63)

Experiment 2
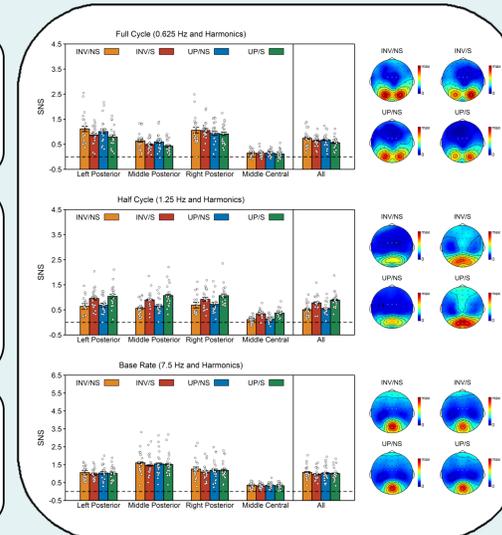
1. **Sync (**)**: NS > S (d = 0.70)
2. **Region (***)**: Lat > mid (η_p^2 = 0.75)

1. **Sync (***)**: S > NS (d = 1.86)
2. **Config (**)**: UP > INV (d = 0.61)
3. **Region (***)**: Post > cent (η_p^2 = 0.75)

1. **Sync (**)**: NS > S (d = 0.61)
2. **Region**: Mid > lat (η_p^2 = 0.73)

Ratings

Experiment 1
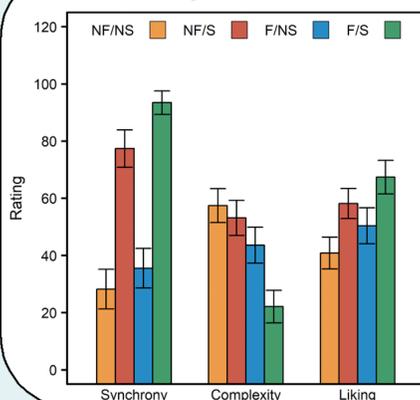
Experiment 2
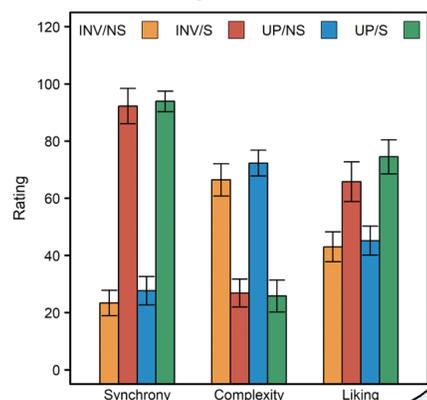
What Predicts Liking?
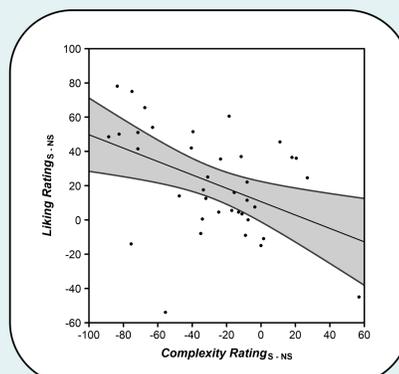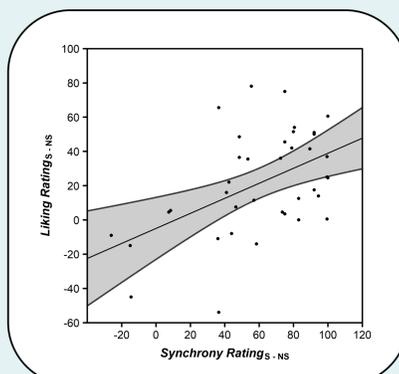
Summary

Half cycle response (= movement processing):
→Posterior and frontocentral activation
→Stronger for synchronous movements, particularly when fluent
→Stronger for upright than for inverted dancers

Full cycle response (= body processing):
→Selective lateralized posterior activation
→Stronger for non-fluent and for asynchronous movements

Base rate response (= contrast processing):
→Selective middle posterior activation
→If anything, stronger for asynchronous movements

Conclusion

The brain has dedicated mechanisms for processing **biological motion** of single (Grossman et al., 2000) as well as multiple individuals (Cracco et al., 2019)

We show that also **social relationships among action trajectories** of multiple individuals are processed.

This information is used to bind together individual movements into **configural group representations** to which the brain entrains.