Neural correlates of disambiguating an ambiguous multisensory motion stimulus

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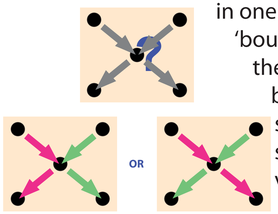
Introduction

Vision appears to be the dominant influence when we interpret motion in the world around us, but information from the other senses can help to interpret an otherwise ambiguous stimulus. An example of this is the bounce/stream illusion. The bounce/stream illusion arises in the context of an ambiguous visual display in which two identical objects approach each other, overlap and then move apart. This visual display is typically interpreted in one of two ways: The two objects exchanged trajectories at the point of overlap (i.e., they 'bounced' off each other) or the two objects continued on their original trajectories (i.e., they 'streamed' past each other). Although no information is available in the display to bias an observer toward one interpretation or the other, in a majority of trials the stream response is reported (e.g., Bertenthal et al. 1993). However, when an auditory stimulus is added to the presentation at the moment of overlap, this tendency reverses, and the bounce response becomes dominant (Sekuler et al. 1997).



Previous Explanations for the Bounce/Stream Percept

Under AV conditions, different networks are activated when bounce as opposed to stream is reported (Bushara et al., 2003).

- This was demonstrated using fMRI, which integrates over time. fMRI does not provide evidence for short timescale temporal dynamics.
- Under VO conditions different networks might also be activated depending on the percept.

The Current Experiment

We used the electroencephalogram (EEG) to examine temporal network dynamics in both the AV and VO bounce/stream illusion.

We looked for evidence of different long-range coherence patterns under AV and VO conditions and with regard to bounce versus stream percepts.

The bounce/stream percept might be related to attention (Watanabe & Shimojo 1998), which appears to have signatures in alpha, beta and gamma bands (Sauseng et al., 2005; Gross et al., 2004; Womelsdorf & Fries 2007).

Methods

- 64-channel (+2 EOG) continuous EEG at 2 kHz.
- Filtered from 1 to 50 Hz and epoched from 300 ms before to 1100 ms after visual stimulus onset, baseline corrected, and sorted by condition and response.
- Average-referenced, artifact-rejected epoched data were spline-fitted down to 1024 samples.
- 100 accepted sweeps were randomly selected per condition per response per participant. (Fewer sweeps from some participants.)
- Grand averages created for audio-visual bounce (AVb), audio-visual stream (AVs), visual-only bounce (VOb) and visual-only stream (VOs).
- All data processing was done using Edit (Neuroscan).
- A small yellow dot served as a fixation mark.
- Disks moved toward each other at a rate of 25 deg/sec
- In AV and AO conditions, a 30-msec 1.5-kHz tone was presented via foam-insert earphones when disks overlapped

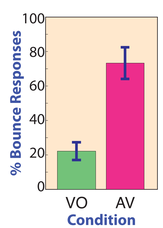
Trial Timeline

Table of sweeps used per participant

Participant	Avb	Avs	Vob	Vos
1	100	100	100	100
2	100	78	89	100
3	100	100	100	100
4	100	100	100	100
5	100	100	100	100
6	97	89	72	100
7	100	76	84	100
8	100	97	100	100
9	100	100	100	100

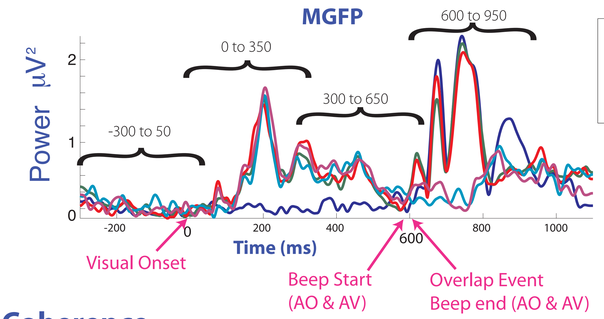
Behavioral Results:

Bounce proportion in the VO and AV cases are similar to those reported in the literature (e.g. Sekuler et al. 1997). Error bars are +/- 2 standard errors ofthe mean



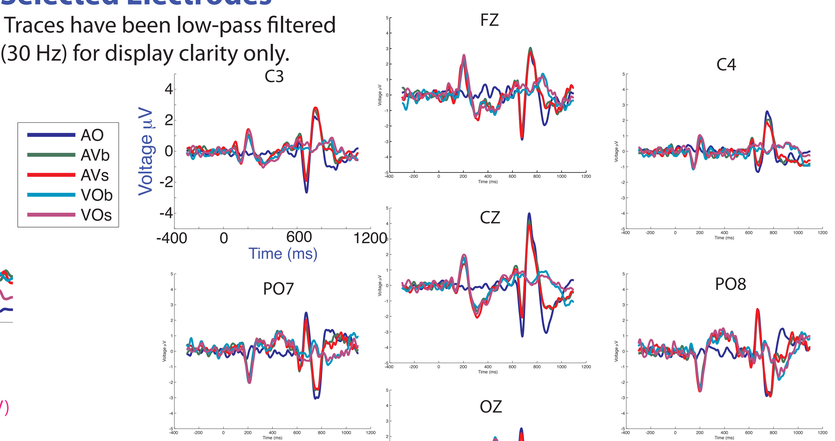
Data Summary

Grand averages and mean Global Field Power (MGFP) data are shown to summarize the EEG data:



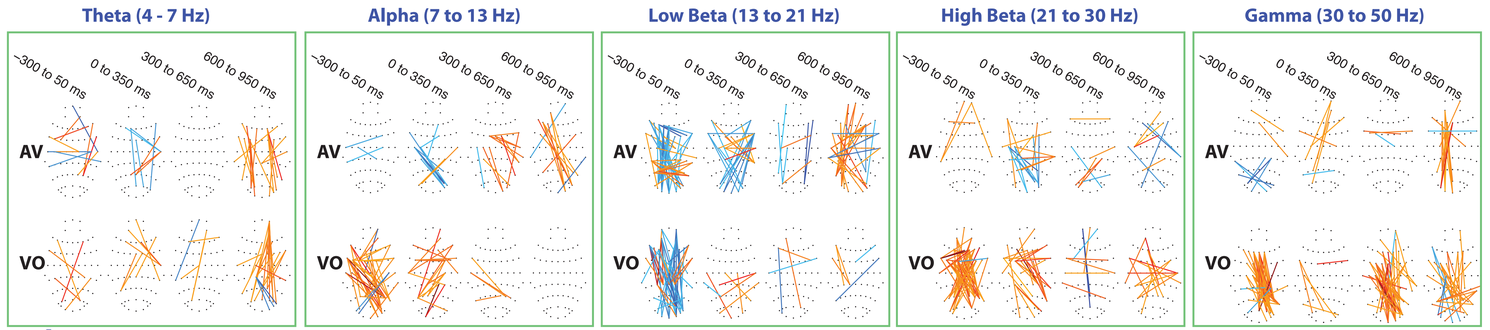
Selected Electrodes

Traces have been low-pass filtered (30 Hz) for display clarity only.



Long-range Coherence

Epoched data was split into four sub-epochs (see braces above) and windowed using a 10% cosine taper. Fisher-Z transformed coherence was calculated between all pairs of electrodes in 5 frequency bands. Paired-T tests were performed comparing bounce to stream coherence measures using a two-tailed **significance criterion of 0.01 (uncorrected)**. To minimize the impact of volume conduction, coherences were only considered significant when the **inter-electrode distance was 10 cm or greater**. Colors represent t-scores, with hot colors showing more coherence in bounce trials and cool colors showing more coherence in stream trials.



Results

VO: Pre-event alpha, high beta and gamma fronto-central to occipito-parietal coherence was larger for bounce than stream responses. Low beta was larger for stream than bounce.

AV: Less evidence of differential coherence before the overlap event compared to VO, with the exception of the low beta band. Post-event coherence diferences were assosciated with the percept.

Discussion

Different coherence patterns are consistent with the possibility that bounce vs stream percepts are due to differences in network dynamics. Theoretically, attentional dynamics are associated with alpha, gamma and beta coherence and/or band power.

In our task, participants are asked to maintain fixation, not blink, and report bounce or stream. Momentary changes in attention associated with fluctuations in network dynamics could lead to the obtained VO results. In contrast, AV results appear less determined by pre-event dynamics and moreso by the post-event exogenous stimulus features.

Acknowledgments:

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