The Effect of Video Coding on Infant's Fast Periodic Visual Stimulation Data Quality

Emma Kraan*, Heather Wallace*, Stefania Conte

BINGHAMTON UNIVERSITY
STATE UNIVERSITY OF NEW YORK

Psychology Department, Binghamton University

***equal contribution**

INTRODUCTION

Fast periodic visual stimulation (FPVS) is a cognitive neuroscience tool used to collect information about brain activity in response to rapidly repeated visual stimuli through electroencephalogram (EEG) acquisition. In FPVS experiments, participants view rapidly presented stimuli at specified frequencies, which align with the frequencies of responses collected by the EEG. This synchronization results in a high signal to noise ratio (SNR), enhancing data quality and clarity.

FPVS research conducted with young infants and toddlers presents the challenge of maintaining their focus on stimuli presented throughout data collection. There is no standardized procedure for utilizing participant looking time as a criteria of data inclusion. **The current study explores this issue by investigating the effect of different criteria for data on the FPVS data acquisition with infant populations.**

Researchers who have utilized FPVS with infants have used various criteria for inclusion of participant data. One study included data based on the percentage of time the infant spent observing the stimuli during its presentation, as well as data quality, based on an artifact blocking algorithm[1] . While this study found the same effect upon exclusion, there was no investigation into the difference in quality of the data after the exclusion criteria was put into place. Some studies had a researcher utilize a video recording to determine the amount of time the infant spent looking at the screen during data collection [2] and some studies used only the SNR of the EEG data to determine data exclusion [3]. While these studies all utilized different data inclusion criteria pertaining to looking time and data quality, there is no indication that these criteria lead to significant improvements in data quality.

This study aims to determine whether completing a video coding of the infant's looking behavior would result in significant changes in spectra amplitudes or SNRs compared with the inclusion of participants without a video coding procedure.

PARTICIPANTS

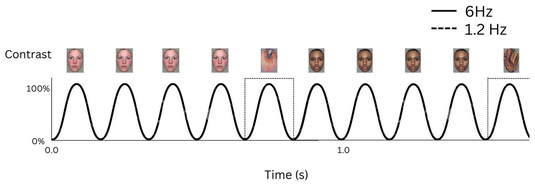
Videos were coded for 30 participants who underwent at least one EEG acquisition. Of these, nine participants came back for a second EEG acquisition, and 2 participants came back three times. A total of 41 EEG data acquisitions were collected and coded for. All participants for whom multiple EEGs were available were tested at least 10 weeks apart. After artifact rejection 9 participants were excluded for not having any artifact-free trials. Additional 10 participants did not look for at least 75% of the time to any of the presented trials. A final sample of 22 EEG acquisitions from 18 participants were included in the analysis. Participants were enrolled between 5.5 and 12.5 months old (*M*= 272.86 days, *SD*= 78.73 days). Participants were divided into 3 groups based on their age, 6 months (*n*=8), 9 months (*n*=6), and 12 months (*n*=8).

Age	Male	Female
6 Months	Multiracial: **0**	Multiracial: **1**
	White: **3**	White: **3**
	Black/ African American: **0**	Black/ African American: **1**
9 Months	Multiracial: **2**	Multiracial: **0**
	White: **2**	White: **2**
	Black/ African American: **0**	Black/ African American: **0**
12 Months	Multiracial: **2**	Multiracial: **2**
	White: **2**	White: **2**
	Black/ African American: **0**	Black/ African American: **0**
Total	**11**	**11**

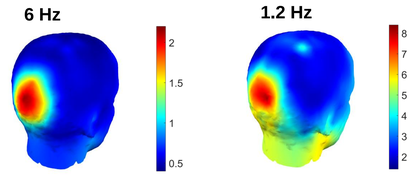
PROCEDURE

Infants were presented with a total of six 20-second trials of faces and objects. These stimuli were presented in one of two experimental conditions: the face stimuli being baseline and the object stimuli being the oddball (FaOb) and the baseline being object stimuli and the face being the oddball (ObFa). Each experiment included three trials per condition presented in random order. The baseline frequency was set at 6Hz and the oddball frequency 1.2Hz, averaging 24 oddball images per trial. All stimuli were presented on a light grey background and equated for illuminance and contrast. Additionally, the cutout frame of stimuli was kept consistent. Attention grabbing images and sounds were presented between trials to (re)direct the gaze of the participant toward the screen.

Throughout the duration of the experiment, infants' neural activity was recorded using a 128-channel Magstim EGI HydroCel Geodesic Sensor Net. Each experimental session took about 3 minutes. A video camera was used to record the participant's gaze during the experiment. Gaze behaviors were later coded offline using Datavyu coding software, and the percentage of looking time was quantified for each trial. Data from each participant was analyzed with (i.e., original) and without (i.e., coded) trials excluded based on looking behavior. In the coded condition, trials with looking times below 75% were marked and excluded from further analyses.

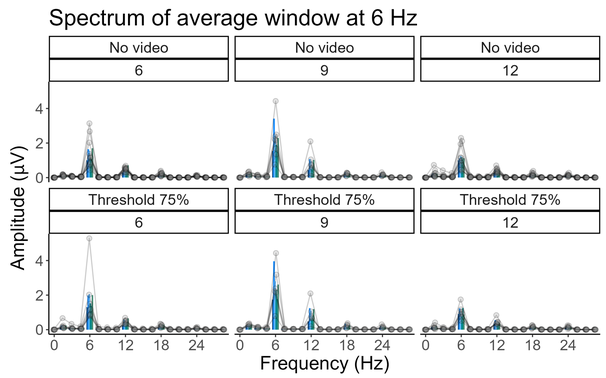


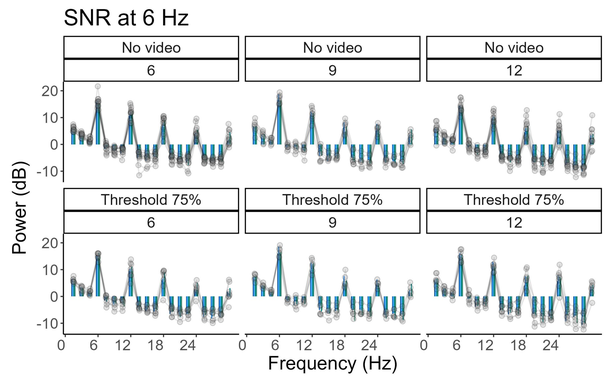
Age	Average trials No video	Average trials Threshold 75%
6 Months	3.5	2.75
9 Months	2.17	1.83
12 Months	3.38	2.38
Total	**3.02**	**2.32**



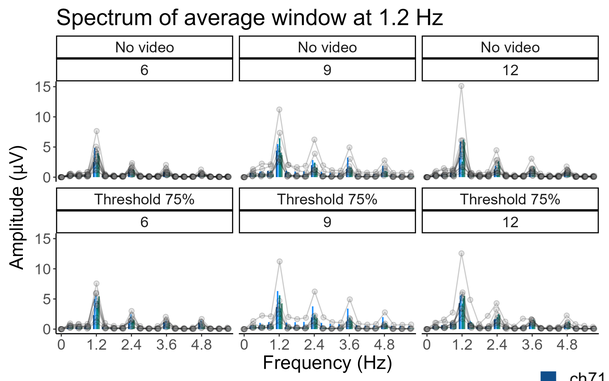
RESULTS

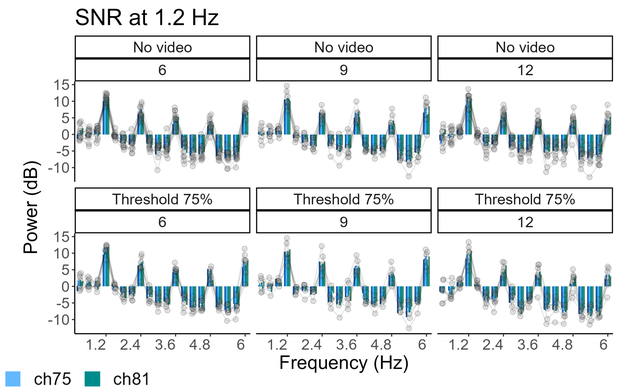
In the 6 Hz condition, a significant activation was observed at the driving frequency ($p < 0.001$), comparisons at higher harmonics were nonsignificant ($p > .05$). ANOVA results revealed significant main effects of Age ($p = 0.001$) and Channel ($p = 0.004$). Comparisons showed a significant difference between channels ch71 and ch74 ($p = 0.043$) and significant differences across all age groups, between 6 and 9 months ($p < 0.001$), 6 and 12 months ($p<0.05$) and 9 and 12 months ($p < 0.001$). For the 6 Hz SNR data, there was a significant activation at the driving frequency only ($p < 0.001$) . ANOVA results showed a significant main effect of Age ($p = 0.010$), with significant differences between 6 and 9 months ($p = 0.01$) and 9 and 12 months ($p < 0.001$).





In the 1.2 Hz condition, a significant activation was observed at the driving frequency only ($p < 0.0001$), comparisons at higher harmonics were nonsignificant ($ps > .05$). ANOVA results revealed significant main effects of Channel ($p >0.01$) but no significant effects of Age or Group. For the 1.2 Hz SNR data, there was a significant activation at the driving frequency ($p < 0.0001$). ANOVA results showed a significant main effect of Channel ($p >0.05$), but no significant effects of Age or Group.





DISCUSSION

The primary aim of this study was to investigate the effect of implementing video coding on the quality of FPVS data collected from infant populations. It was hypothesized that the implementation of video coding procedure would enhance the quality of the FPVS data. Contrary to the initial hypothesis, the results indicated no significant difference in data quality between the video-coded and non-video-coded conditions. However, there were significant differences in the data quality of the different age groups within both conditions.

These findings suggest that, within the current sample and procedure, high quality of FPVS data is available even without accounting for the looking behavior of infant participants.

The significant differences across age groups highlights that while utilizing FPVS data acquisition methods is effective for infant populations, the quality of the data differs across timepoints within the first year of life. **This data suggest that maturational factors within the first year of life impact the consistency of FPVS responses, independent of data analysis procedure.**

A key limitation of this study was the relatively small sample size (*N*=22). This small sample may have contributed to a reduced likelihood that a significant difference would be found between groups. Future research should aim to replicate these findings with a larger sample to determine whether the observed null effects are sample-specific.

While the study contradicted the initial hypothesis, the results highlight the high SNR of FPVS data acquisition within a few minutes of recording. This emphasizes the importance of considering developmental differences when designing and interpreting FPVS studies in infants.

The findings also highlight the **need for further research to investigate the effect of internal consistency reliability measures[4] in datasets with few available trials.** Understanding these factors will be crucial for improving data analysis protocols for FPVS studies conducted on infant populations.

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K99/R00
HD102566
NIH

encode@binghamton.edu