

CONTINGENT NEGATIVE VARIATION AND ATTENTION IN CHILDREN

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Summary

In adults, executive functions have been shown to correlate with the initial portion of the contingent negative variation (CNV) while motor preparation is associated with the late CNV. However, children do not consistently produce these CNV divisions. This may be due to the stimulus intervals used. In this study, we used a standard Go-Nogo paradigm with 2 SOAs (2s, 4s), with 3 behavioral attention measures and a motor speed task in 23 children ages 8-13 years. CNVs on Go trials were more negative than for Nogo trials with both SOAs. Age correlated with the early CNV for short and long SOA conditions, but not with the late CNVs. Two of the attention measures correlated with the early CNV in both the short and long SOA conditions. In a regression analysis, the 3 attention measures (entered together) accounted for 26% of the variance in early CNV of the short SOA after variance related to age and motor speed were removed. Thus, in children, selective attention is a significant predictor of early CNV even when controlling for age and motor speed in the short SOA CNV paradigm, but not the long SOA condition. A 2 second SOA CNV paradigm may be ideal for studying attention in children.

Introduction

In adults, the CNV splits into two separate components when recorded with sufficient duration in SOA. The early component (the O-wave) has been linked to orienting processes, and has been associated with the dorsolateral prefrontal cortex.⁵ The later component (the E-wave) is associated with preparation for a motor response to stimuli, and with the motor cortex.^{3,4} The CNV amplitude is known to relate to anticipation and orientation to environmental events, attention to stimuli, arousal, and preparation for a motor response, processes that are disrupted in children having disabilities as autism and ADHD.² The CNV in children is different from that in adults, with questions as to whether children produce it, when it develops and how best to measure it. Performance on attention tasks relates to the CNV amplitude in children.^{2,6} However, experimental variability in length of SOA, stimulus modality, stimulus duration, and stimulus intensity differ across studies so no strong conclusions as to the relationship of attention and the CNV amplitude have been established.

Purpose

The purpose was to compare procedures for eliciting the CNV in a Go-Nogo paradigm to check for morphology changes with age and the impact attention may have on the CNV amplitude. We hypothesized that: (1) children who generate the greatest CNV will perform best on behavioral measures of attention; and (2) there will be differences between O-wave and E-wave as a function of the SOA and age.

Method

Participants

23 children

- Thirteen 8-10 year olds (5 males, 8 females)
- Ten 12-13 years olds (4 males, 6 females)

Procedure

- 2 sets of 30 Go and 30 Nogo trials with S1-S2 stimulus onset asynchrony (SOA) at 2 s for set 1 and 4 s for set 2. SOA conditions counterbalanced.
- S1 = circle; S2 = car (see figure 1)
- Stimulus duration 250 ms; ITI = 2 to 7 s
- Go trial = green warning circle
- Nogo trial = red warning circle (see figure 1)

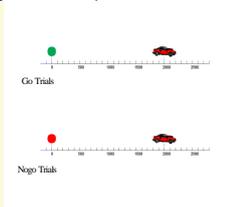
Electrophysiological Measurements

- 29 scalp sites, 2 bipolar eye monitors
- Averaged amplitude computed for four 400 ms and one 1200 ms epochs at Fz, Cz, Pz for 2 s SOA
- Averaged amplitude computed for nine 400 ms and one 3200 ms epoch at Fz, Cz, Pz for 4 s SOA
- Regression to remove EOG artifact
- Rereferenced offline to averaged ears
- Recorded at 500 samples/s; .03 to 30 Hz band pass
- Residualized CNV calculated by regression partialing Nogo CNV from Go CNV.

Attention Behavioral Measurements

- Administered in randomized order
- d2 test of attention (Brickenkamp & Zillmer, 1998)
- Selective Letter Cancellation
- Symbol Digit Modalities Test (SDMT)
- Motor speed (Crossing Off A's task)

Figure 1 - stimuli presentation Set 1, 2 s SOA



Results

Comparisons Between Go and Nogo, SOA Duration, and Age

A 2x2x2 mixed ANOVA using the full CNV epoch with trial type (Go and Nogo) and SOA duration (2 s and 4 s) as the within factors and age group as the between factor revealed that Go trials were more negative than Nogo trials, $F(1,21) = 15.36, p = .001$. There were no significant differences for the SOA duration or age groups. ANOVA using the early CNV (400-800 ms) differed between age groups, $F(1,21) = 5.13, p = .034$ (see Figures 2 - 5).

Figure 2 - Grand Averages for 8-10 year olds, 2 s SOA

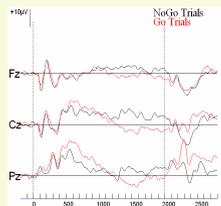


Figure 3 - Grand Averages for 12-13 year olds, 2 s SOA

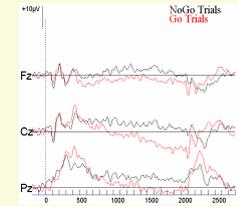


Figure 4 - Grand Averages for 8-10 year olds, 4 s SOA

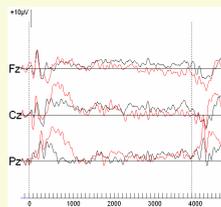
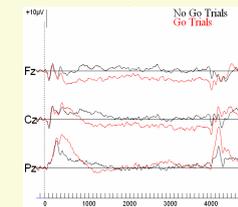


Figure 5 - Grand Averages for 12-13 year olds, 4 s SOA



Developmental Trends

Age correlated with the early CNV for both the 2 s and 4 s SOA conditions ($r = -.42, p = .046$; $r = -.460, p = .027$ respectively), but not with the late CNVs ($r = -.17$ and $-.11$ respectively). Age did not correlate with the full CNV epoch for either the 2 s SOA or 4 s SOA.

Figure 6 - Cancellation test performance and the residual of the early CNV 2 s SOA

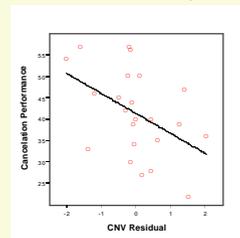
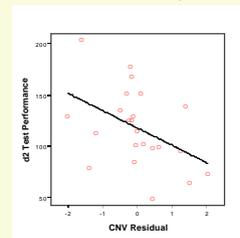


Figure 7 - Performance on d2 test and the residual of the early CNV 2 s SOA



CNV Amplitude and Attention Measures

Two of the attention measures correlated with the residual of the early CNV (400 - 800 ms) in the 2 s and 4 s SOA conditions: cancellation ($r = -.46, p = .028$; $r = -.46, p = .029$, respectively) and d2 ($r = -.44, p = .035$; $r = -.46, p = .029$, respectively). See Figures 6 and 7. In a regression analysis, the 3 attention measures (entered together) accounted for 26% of the variance ($p = .048$) in early CNV of the 2 s SOA after variance related to age on the first step (18%, $p = .046$) and motor speed on the second step (2%, $p = .109$) are removed.

Conclusions

- Children 8 to 13 years display a CNV in Go trials compared to Nogo trials.
- The older children exhibited greater early CNV (O-wave) than the younger children. There was not a developmental trend for the late CNV (E-wave).
- The early CNV (O-wave) relates to attention measures, especially the d2 and cancellation tests, but the late CNV (E-wave) does not relate to attention measures (replicating Segalowitz et al., 1992).
- For children, performance on attention measures relates more to early CNV amplitude (O-wave) than does age. Motor speed performance does not relate to the CNV amplitude in the early, late, or full epoch.

References

1. Brickenkamp, R., & Zillmer, E. (1998). *The d2 Test of Attention manual*. Cambridge, MA: Hogrefe & Huber.
2. Dumais-Huber, C., & Rothenberger, A. (1992). *Journal of Psychophysiology*, 6, 225-239.
3. Loveless, N. E., & Sanford, A. J. (1974). *Biological Psychology*, 1(4), 303-314.
4. Rohrbaugh, J., & Gaillard, A. (1983). In A. Gaillard & W. Ritter (Eds.), *Tutorials in Event Related Potential Research: Endogenous Components*. Amsterdam: North Holland.
5. Rosahl, S. K., & Knight, R. T. (1995). *Cerebral Cortex*, 5, 123-134.
6. Segalowitz, S. J., Unsal, A., & Dywan, J. (1992). *Developmental Neuropsychology*, 8(2,3), 297-298.

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