SESSION III

COMPUTER ANALYSIS OF PHYSIOLOGICAL EVENTS DURING COMPLEX TASK PERFORMANCE

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Heart electrophysiology as a dependent measure in children

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This study extends the cardiac component analysis technique, reported by Eddy and his co-workers (Eddy, McKendree, McKenzie, & Bremner, 1982; McKendree, 1982), to children. Three male children between the ages of 8 and 10 years served as subjects and were tested on several days. In particular, the children were taught a simple relaxation task and a simple cognitive task. The cardiac electrophysiology of these children was statistically tested to determine whether there was a reliable difference between psychological tasks but only minimal variance within psychological tasks. The results of testing the ST component of the cardiac electrophysiology confirmed our hypothesis that there is a statistical difference between tasks ($p < .001$) but not within tasks when tested over time.

Eddy, McKendree, McKenzie, and Bremner (1982) reported that statistical analysis of the components of cardiac electrophysiology yielded reliable differences between psychological tasks performed by adult human subjects. Their method of analysis was to test the time duration of the PQ interval of the cardiac electrical response (cardiac component analysis, CCA). The success of their technique was verified by McKendree (1982), who demonstrated a statistical difference in both the PQ and the ST components when testing the difference between a meditational task and a complex cognitive task. Both of these reports used a single-subject experimental design with adult subjects.

The present study extends these findings to children and uses less demanding psychological tasks. Three male children between the ages of 8 and 10 years served as subjects. Each boy was tested five times, and each of the testing sessions was on a different day. In particular, the children were taught a simple relaxation task and a simple cognitive task. The cardiac electrophysiology of these children was statistically tested to determine whether there was a reliable difference between psychological tasks but only minimal variance within psychological tasks.

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METHOD

Subjects

The subjects selected for this study were three boys 8 to 10 years old. They were participants in a special training program for children experiencing various psychomotor dysfunctions. This training program was conducted at the Trinity University Motor Behavior and Learning Laboratory.

Apparatus

The electrophysiological data used in this study were recorded on a Narco Bio-Systems Physiograph (Model MK-4) and simultaneously on a Vetter four-channel cassette tape recorder. These recording devices received their inputs from Midwest Monitoring (Model 1A-5S) paste-on pre-jellied EKG electrodes. The analog tape made during the testing sessions was analyzed off-line by a DEC PDP-11/24 computer. The PDP computer converted the analog signal to digital values (A/D conversion) and analyzed these digital data with a cardiac component analysis program. This program was originally reported by Eddy (Eddy et al., 1982) and was modified specifically for this study by Zintgraff (Bremner, Yost, & Zintgraff, 1985). The output of this program is a duration value for both the PQ and ST component of the EKG. The ST values were submitted to the Statistical Analysis System

(SAS) program run by an IBM 3031 computer. The SAS program was used to apply an analysis of variance to the ST scores of each task for each subject.

Procedure

Data were collected for each of the three subjects during three tasks: baseline, meditation, and compound stimuli. The baseline task was one in which the subject was instructed to sit in a recliner chair as still as possible for 20 sec. During the meditation task, the subject listened to a meditation tape that presented a backward countdown and a slow-running metronome. The tape then instructed the subject to visualize a favorite resting place (McKenzie, 1974). This sequence lasted for 20 sec.

In the third task, three sensory stimuli were presented under the control of an Apple computer. The three stimuli making up the compound stimulus were visual, auditory, tactile, respectively. The visual stimulus was a double Lorraine cross on the television monitor; the auditory stimulus was a 1000-Hz tone over the earphones; and the tactile stimulus was a vibrator modified from an electric toothbrush and strapped over the subject's ankle. The intent was to bombard the sensory system and the reticular formation with an abundance of information. In addition, the subjects were instructed to press a button immediately following the termination of the compound stimulus. This pseudo-reaction time task was used only to encourage the subject to maintain his vigilance. The compound stimulus was presented at two different durations: 10 and 20 sec. Only the data recorded during the 20-sec duration were analyzed.

The data analysis was done by the CCA program described above. The output of this program was the ST component of the typical EKG: the time duration from maximum deviation of S to the end of T. Twenty consecutive ST durations were collected for each treatment for each subject. These 60 scores were submitted to analysis of variance (SAS) modified for single-subject design (Kratowill, 1978; Shine, 1982).

RESULTS

The results of the single-subject design are presented in Table 1, which shows the means and standard deviations (in milliseconds) of the ST component of the heart response for each subject under varying conditions.

In order to facilitate an understanding of the results, the ST data collected on each subject were statistically examined separately. The first, second, and third subjects were given the fictitious names of Brad, Frank, and Chris, respectively. An analysis of variance was applied to test the ST component of the heart response between the three tasks (baseline, meditation, and compound stimuli). The analysis of Brad's ST data across tasks was significant with $p < .001$. A separate analysis of variance was applied to the ST data of each of the other two subjects, with results identical to Brad's. In all three cases, the

Table 1
Means (in Milliseconds) and Standard Deviations of the
ST Components of the Heart Responses for Three Subjects

Condition	Brad		Frank		Chris	
	Mean	SD	Mean	SD	Mean	SD
Baseline	85.345	3.1	74.125	2.0	68.575	1.4
Meditation	82.345	4.0	79.025	6.9	65.425	2.0
Compound Stimulus	85.650	3.0	82.200	3.8	66.050	1.2

difference among tasks was significant with the identical probability ($p < .001$). Fisher's (1950) test for the probability of combined probabilities was applied to all three subjects and was significant ($p < .01$). A test of the within-sample variance for the ST interval was not significant in any of the three subjects ($p < .079$).

DISCUSSION

The statistics reported in the Results section support the hypothesis of this study, that the ST component of the cardiac electrophysiology is task driven. The results presented in Table 1 show that the ST component is always shorter during the meditation task than during the compound stimulus task. It has been reported that the ST component is sensitive to psychological workload (Armstrong, 1985).

However, this intertask difference is not shown when comparing the baseline-task ST data to either the compound-stimulus- or the meditation-task data. We believe this is so because, during baseline, the subjects did not sit still as instructed, whereas, during the meditation task, subjects were occupied with listening to the tape and with their own process of imagery. Visual observations of the subjects support this belief. With the subjects who are at present being tested in our laboratory, we are attempting to reduce these apparent competing movement responses during the baseline task by having the subjects wear blindfolds. The irregularity of the ST component during the baseline samples might also reflect the psychological profile of these subjects. Since we collect an extensive psychological workup on each child in our training program, we were able to compare activity ratings with these ST scores. Although none of these children was hyperactive, an overall interpretation of the results of their psychological test battery was that they were both more active and more impulsive than normal. It is apparent that in future studies we need to find ways to obtain a more homogeneous baseline sample.

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