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ATTACHMENT ORGANIZATION AND HEART-RATE VARIABILITY IN THE STRANGE SITUATION [1]

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The present study is a part of a larger research focused on the interrelations among behavioral and representational organizations of attachment and cardiac activity. Despite attachment theory's general assumptions about species-characteristic behavioral systems and, more specifically, about the biological function of the attachment system, the empirical research has been focused on the study of psychological and behavioral processes. In contrast, studies about the relations between biological or physiological processes and the quality of attachment are still scarse within recent attachment literature. However, the inclusion of biological processes may be of special relevance for validation of assessments and interpretations of attachment patterns found in children and in their parents.
Following these considerations, the present study aims to explore at the empirical level the relations between the different attachment patterns and the cardiac activity assessed during the Strange Situation, on a sample of mothers and their twelve-months infants.

METHOD

The sample consisted of 31 healthy Portuguese infants aged 12 months (20 boys and 11 girls) and their mothers. The children's families represent a wide range of socio-economic status. All the infants stay at home during the day with their mothers or other familial caretakers.
The infants were observed during the Strange Situation. The quality of infant-mother attachment was analysed from the videos by trained observers who had previously been trained by an expert judge (Dr. Karin Grossmann) and they have been certified for reliability in the classification of 30 Strange Situations from the Regensburg and Bielefeld samples. For the Portuguese sample reliability between the observers in terms of ABC classification was 96%. The D-classification was not used in the present study.
During the Strange Situation, infants' and mothers' electrocardiograms were continuously recorded by means of a Holter (Mortara, model PR-4). The Holter was kept in a little jacket on the infant´s chest and was attached to the mother' waist.
Data were played back in real time and A/D conversion was performed at 128 HZ using the Mortara software for postprocessing analysis of HRV. When necessary, artifacts and ectopic beats were excluded (not interpolated). The heart periods were converted to heart rate (HR) in beats per minute for each 1-second interval.

Infant' and mother's cardiac activity during the Strange Situation was defined as the change of mean heart rate (beats per minute) from mean HR in episode 2 (considered as the base line) to each of the episodes from 3 to 8. In this sense, change from base line measure was used to describe a physiological response.

RESULTS

FIG. 1 shows the distribution of attachment groups for the overall sample of 31 infants: 14 were classified as secure, 10 as avoidant and 7 as ambivalent. For technical reasons the HR analyses were conducted only with a sub-sample of 19 out of these 31 subjects, whose distribution is also shown in FIG. 1: 7 were classified as secure, 7 as avoidant and 5 as ambivalent.

Insert FIG. 1 about here

Based on the overall sample (31 infants) a discriminant analysis was performed in order to examine in detail the relations between the attachment groups and the scores obtained in the four interactive behavior scales: proximity and contact seeking, contact-maintaning, resistant and avoidant behaviors.

Insert FIG. 2 about here

As shown in FIG. 2, the first discriminant function separated maximally the avoidant group from the others. The second function discriminated the secure group form the ambivalent group. Using the discriminant weights, 93% of the infants were correctly classified (90% avoidant, 93% secure and 100% ambivalent). The scales that contributed significantly to the groups discrimination were avoidance and resistance at the episode 8 and contact-maintaning at the episode 5.
As we can also see in FIG. 2, there are two infants whose coordinates in the canonical variables show an ambiguous position in relation to the mean coordinates of the respective groups (that is, a secure infant and an avoidant infant). These two infants were not included in our HR sample.

The main objective of the present data analysis was to examine the HR variability during the Strange Situation episodes for the A/B/C attachment groups. To assess

statistical significance of changes in behavioral and physiological measures, analyses of variance with repeated measures (MANOVA's) were used with the Greenhouse-Geisser corrections for degrees of freedom to control for heterogeneity of variance. The statistical software BMDP version 7.0 program 4.V was used.

A combination of the traditional A and C groups would have been inappropriate both from conceptual and empirical reasons. As we can see in FIG. 3, the HR measures of the A and C infants are extremely different. So, we will consider separately the HR variability for the 3 attachment groups.

Insert FIG. 3 about here

Changes in cardiac activity were assessed as the difference in HR in each of the episodes 3 to 8 and the HR in the episode 2 (considered as the base line). There were no differences among the 3 attachment groups in the HR base line. However the behavioral differences among the 3 attachment groups were reflected in the cardiac activity during the Strange Situation, as show in TABLE 1:

Insert TABLE. 1 about here

First, there is a significant difference in the HR means among the attachment groups ($p= 0.034$).
Second, there is a significant main effect for episode ($p= 0.0002$). This main effect is translated in a significant HR increase from episode 3 to episode 4 and from episode 5 to episode 6.
Third, a siginifcant interaction between episode and attachment group ($p= 0.005$) is also found.
In order to investigate further this interaction effect, we contrasted the secure vs. the ambivalent groups and the secure vs. the avoidant groups.

Insert TABLE. 2 about here

TABLE 2 shows a significant difference in the HR mean between secure and ambivalent infants ($p=0.02$): the ambivalent babies have a higher HR increase

during the Strange Situation. The difference in the HR of secure and avoidant babies was not statiscally significant.
As we can also see in TABLE 2, there is a significant difference in the mean HR across all the Strange Situation episodes between secure and ambivalent groups (p =0.02), but again no significant differences between secure and avoidant infants. Examining further this interaction between episode and attachment groups, that is, between secure amd ambivalent infants, we found another significant difference between these two groups, as shown in TABLE 3.

Insert TABLE 3 about here

The HR of ambivalent babies decreases between episode 4 and 5 contrasting with the increase of the HR of secure infants (p= 0.004). From episode 5 to 6 the mean HR of ambivalent babies show a greater increase than that of the secure babies (p=0.02). From episode 6 to 7 we observe no significant differences in the mean HR variation but, from episode 7 to episode 8 the ambivalent group shows a greater decrease in terms of their HR mean than the secure group (p=0.02).

In regard to the Mothers'HR, no significant diferences were found in terms of the 3 attachment groups. Results in TABLE 4 indicated that there is a significant main effect of episode, but the interaction between episode and attachment group is not statiscally significant.

Insert TABLE 4 about here

As shown in TABLE 5, there is a significant increase in the mean HR from episode 3 to 4 and again from episode 7 to 8.

Insert TABLE 5 about here

We also performed Spearman correlations between infants HR and the scores obtained in the interactive behavior scales as well as between mothers' HR and these scores.

At the episode 7 the infants' HR is negatively correlated with avoidant behavior shown at episode 5 (r= -0.49, p= 0.03) and positively correlated with proximity seeking (r=0.58, p=0.009), contact-maintaining (r= 0.55, p=0.02) and resistance (r= 0.60, p= 0.009) at the episode 8, but negatively correlated with avoidance (r= -0.58, p=0.01) also ssessed at the episode 8.
At the episode 5, mothers' HR is positively correlated with infants' proximity seeking (r=0.50, p= 0.02).
Mothers' and babies' HR correlations were also performed for episodes 5 and 8: we found a significant negative correlation between mothers HR at episode 5 and babies HR at episode 8 (r=0.49, p=0.03).

DISCUSSION

Regarding the traditional -forced- ABC classification the proportion of secure and insecure children is not entirely comparable to previous findings in other non-risk-samples: in our Portuguese sample insecurely attached children are over-represented. This is the first study based on the Strange Situation conducted with Portuguese infants. So, we cannot compare our distribution with others from similar national samples. Although this distribution should be carefully explored, results from DISCRIM analysis suggest that the ways in which the infants of our sample were classified is consistent with the stated specifications. We need further studies, examining larger Portuguese samples in order to receive supportive evidence for disucssing this result.
The HR patterns of our infants provide further validation of the Strange Situation procedure and the behavioral criteria used for the classification of the quality of attachment. First, HR increases during the two separations from the mother (episodes 3 to 4 and 5 to 6) in all attachment groups. Second, the behavioral differences among the three attachment groups were reflected in the cardiac activity during the Strange Situation. For this difference the ambivalent group offers a significant contribution, as they seem to be more reactive to the separations and reunions with their mothers. Ambivalent babies have a greater HR increase during the Strange Situation, showing greater increase in the two separation episodes. On the other side, during the two reunion episodes their HR show a decrease. These results support the idea that they are more preoccupied with the accessibility in regard to the attachment figure.

Our results indicate that even the avoidant babies though exhibiting low behavioral distress were somehow affected by the Strange Situation. In the second separation from mother they show a significant HR increase comparable to what happens with the secure babies. Thus the attachment system in avoidant babies seems to be activated in a way comparable to the secure babies. However, in contrast with the secure babies, the avoidant infants are more appeased by the return of the stranger than by the return of their mothers. During the second reunion, avoidant babies seem to have a greater HR increase (without statiscal significance) in contrast with the HR decrease observed in secure babies. This observation suggests that after a second separation secure babies need their mothers in order to become more tranquilized.

Our results show a different HR pattern for the ambivalent babies compared with the secure babies. In contrast, the difference between the HR patterns of the secure and avoidant babies has not entirely received statiscal support in our study. However, it seems that the second reunion may be the episode where the differences between secure and avoidant babies may become evident We need further studies with larger samples in order to clarify this issue.

In regard to the mothers' HR no significant differences were found in terms of the 3 attachment groups. However avoidant babies' mothers seem to have a HR increase during the Strange Situation. All the mothers have a greater HR increase when they are separated from their babies but also in the last episode of the Strange Situation.

This study should be taken as a first approach of a very complex problematic. There are several limitations in our study, particularly the small size of the sample. We need also to improve data analysis in terms of the examination of the interactions between cardiac activity and behavioral phenomena. Taking into account these limitations, our findings seem to offer evidence for the validity of the Strange Situation procedure in the assessment of individual differences in the attachment organization. Our study illustrates that biobehavioral associations between attachment system and cardiac activity address a number of interesting issues that deserve further investigation.

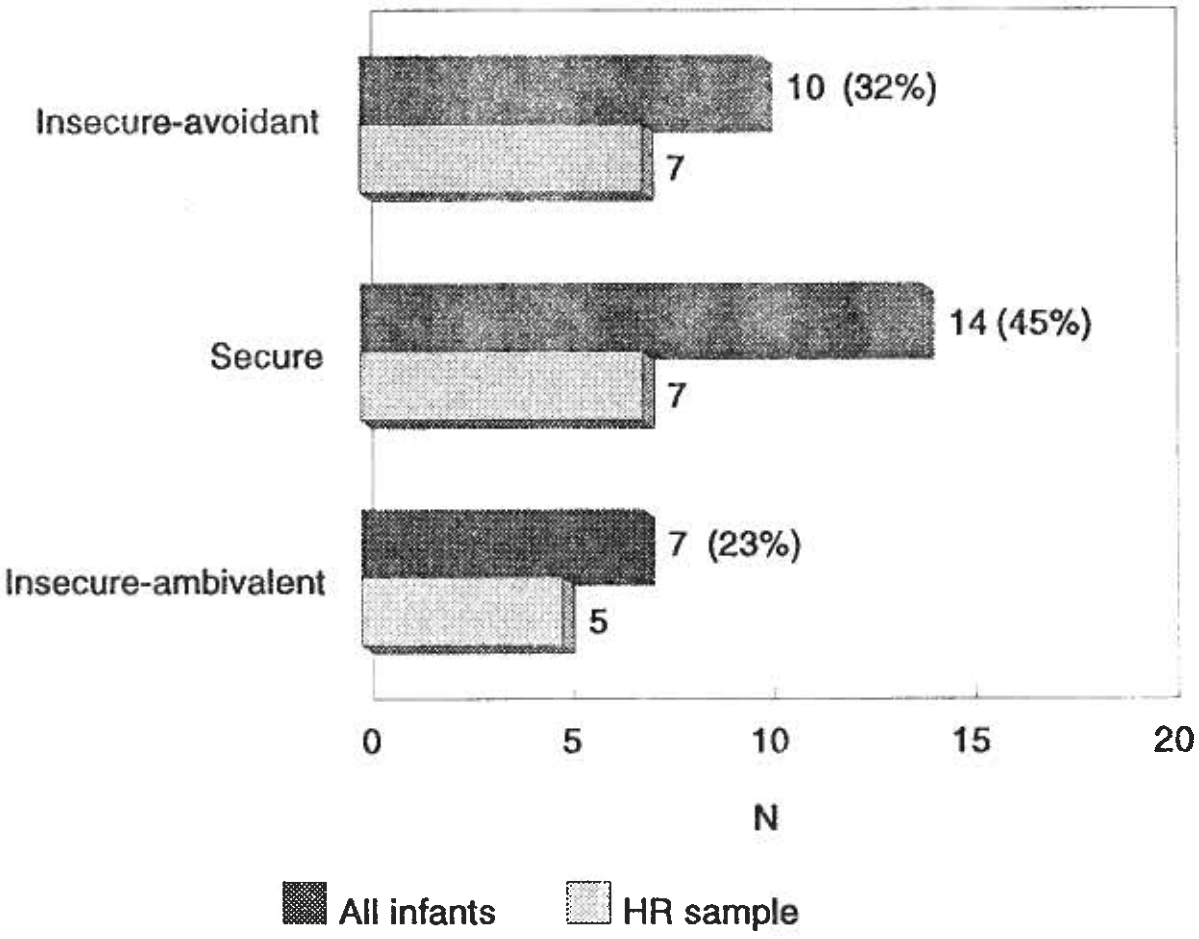

Fig.1 - Distribution of attachment groups

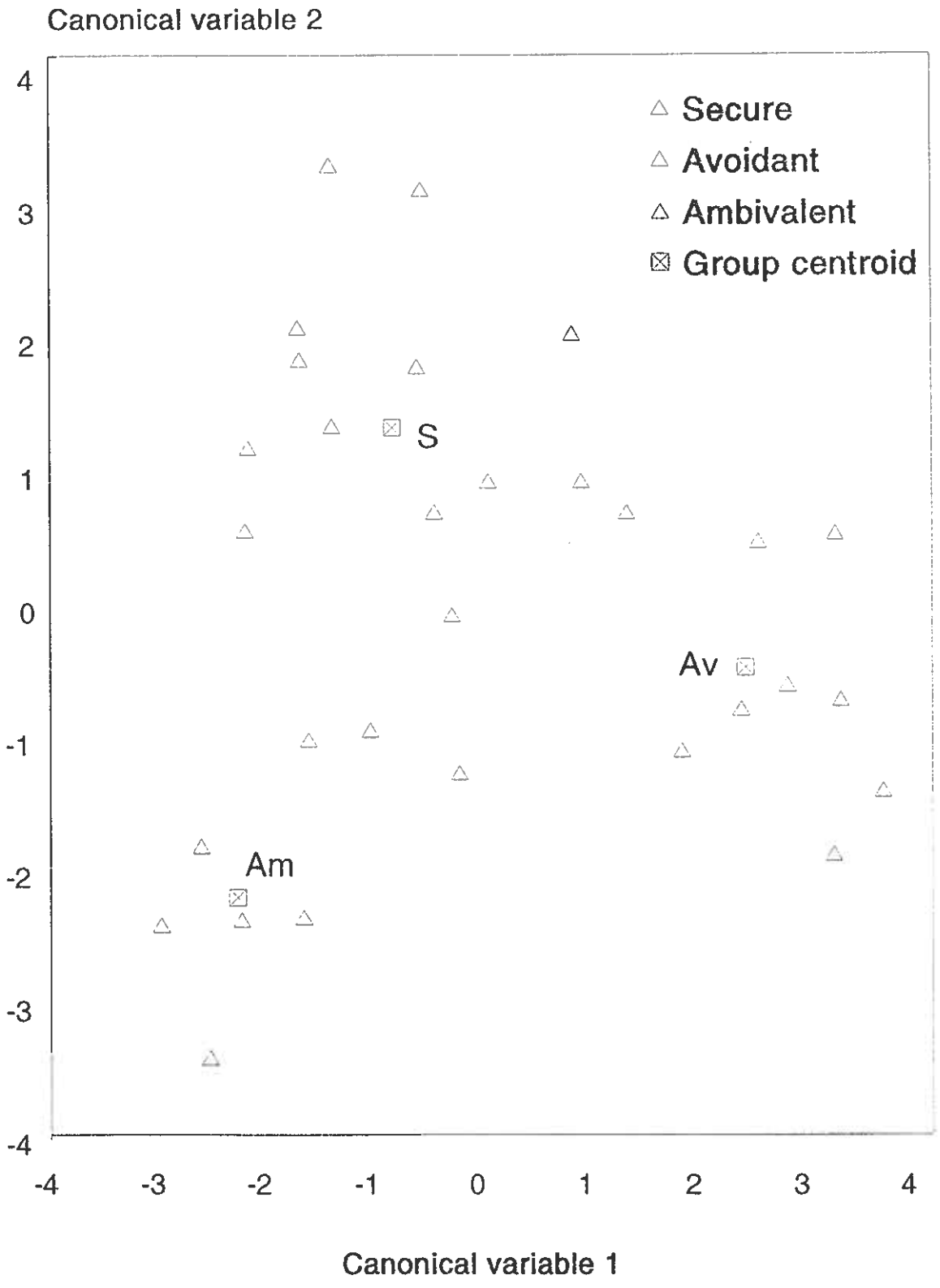

Fig. 2 - Discriminant functions analysis for the interactive scales

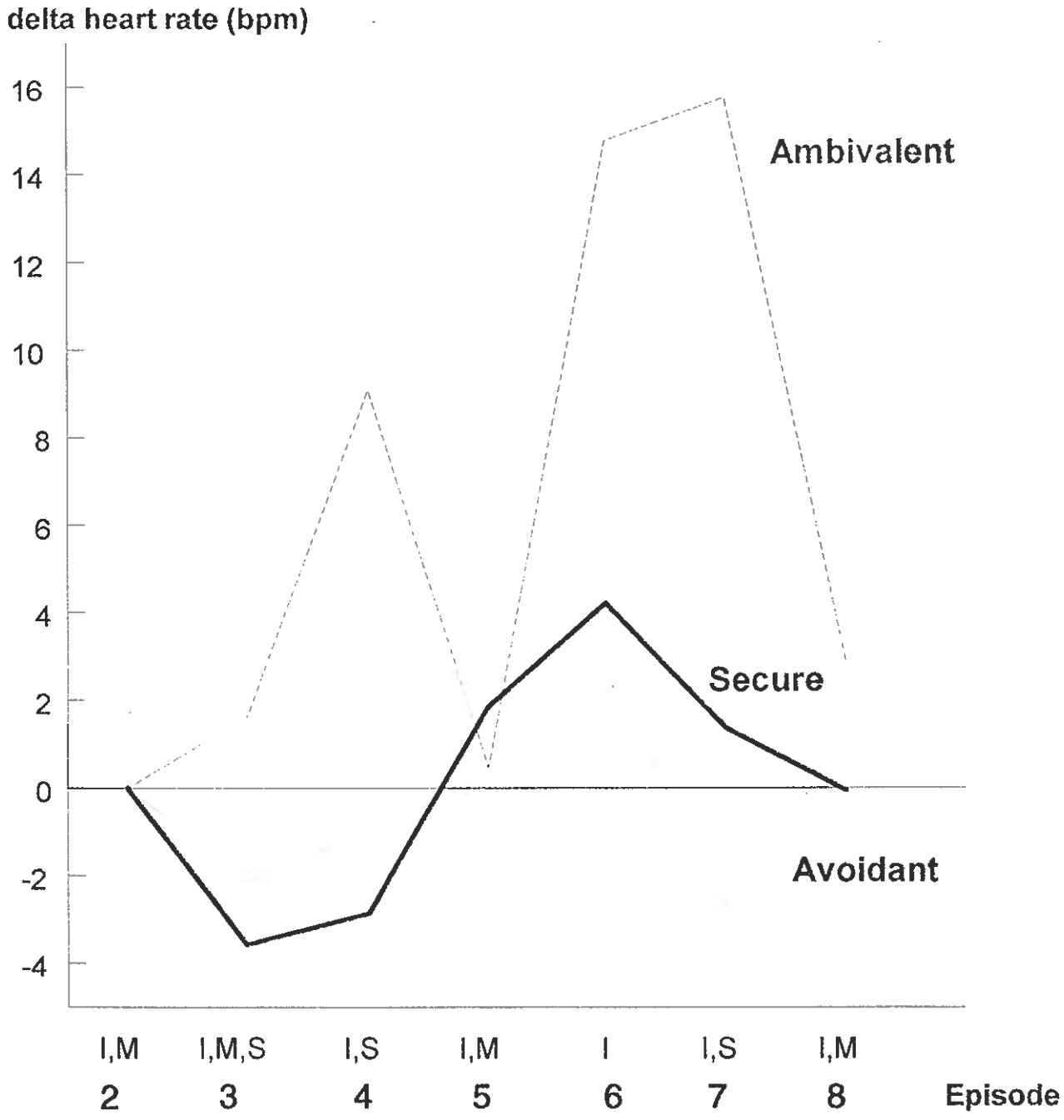

Fig.3 - Changes in infants' heart rate during the episodes for different attachment groups

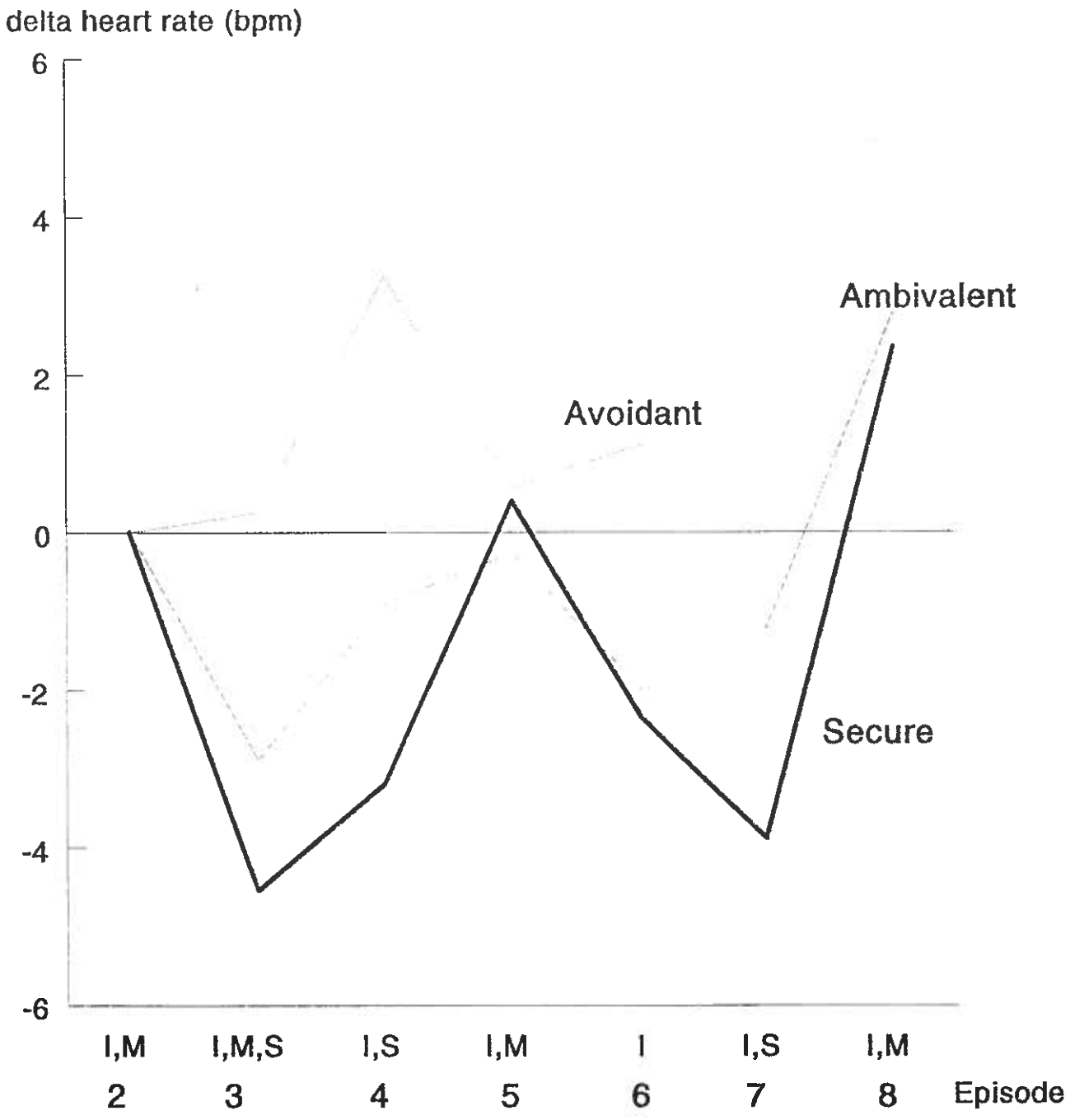

Fig.4 - Changes in mothers' heart rate during the episodes for different attachment groups

Table 1. Analysis of Variance for heart rate in terms of attachment group and episode

Source of variation	Sum of squares	d.f.	Mean square	F	Tail prob.	Greenhouse Geisser prob.
Attachment group	1251.66	2	625.83	4.20	0.034	
Error	2381.61	16	148.85			
Episode	871.78	5	174.36	5.69	0.0002	0.0011
Episode x Attach.	855.96	10	85.60	2.79	0.005	0.015
Error	2453.14	80	30.66			

Greenhouse-Geisser epsilon factor for degrees of freedom adjustment = 0.698

Table 2. Contrasts of heart rate between Secure and Insecure groups during the episodes

Contrasts	Sum of squares	d.f.	Mean square	F	Tail prob.	Greenhouse Geisser prob.
Secure vs Ambivalent	925.53	1	925.53	6.22	0.024	
Secure vs Avoidant	4.76	1	4.76	0.03	0.8	
Error	2381.61	16	148.85			
Episodes x (Sec vs Amb)	528.40	5	105.68	3.45	0.007	0.018
Episodes x (Sec vs Avoid)	97.44	5	19.48	0.64	0.6	-------
Error	2453.14	80	30.66			

Greenhouse-Geisser epsilon factor for degrees of freedom adjustment = 0.698

Table 3. Contrasts of heart rate between Episodes

Contrasts	Sum of squares	d.f.	F	Tail prob.
Episode 3 vs Episode 4	89.80	1	4.85	0.042
Episode 4 vs Episode 5	8.77	1	0.37	0.55
Episode 5 vs Episode 6	379.48	1	11.88	0.003
Episode 6 vs Episode 7	51.98	1	1.84	0.20
Episode 7 vs Episode 8	114.11	1	3.74	0.07

Table 3. Contrasts of heart rate between Secure and Ambivalent groups across episodes

Contrasts	Sum of squares	F (1,16)	Tail prob.
Episode 3 vs Episode 4	65.97	3.57	0.07
Episode 4 vs Episode 5	258.74	10.85	0.004
Episode 5 vs Episode 6	207.01	6.48	0.02
Episode 6 vs Episode 7	21.47	0.76	0.4
Episode 7 vs Episode 8	192.39	6.31	0.02

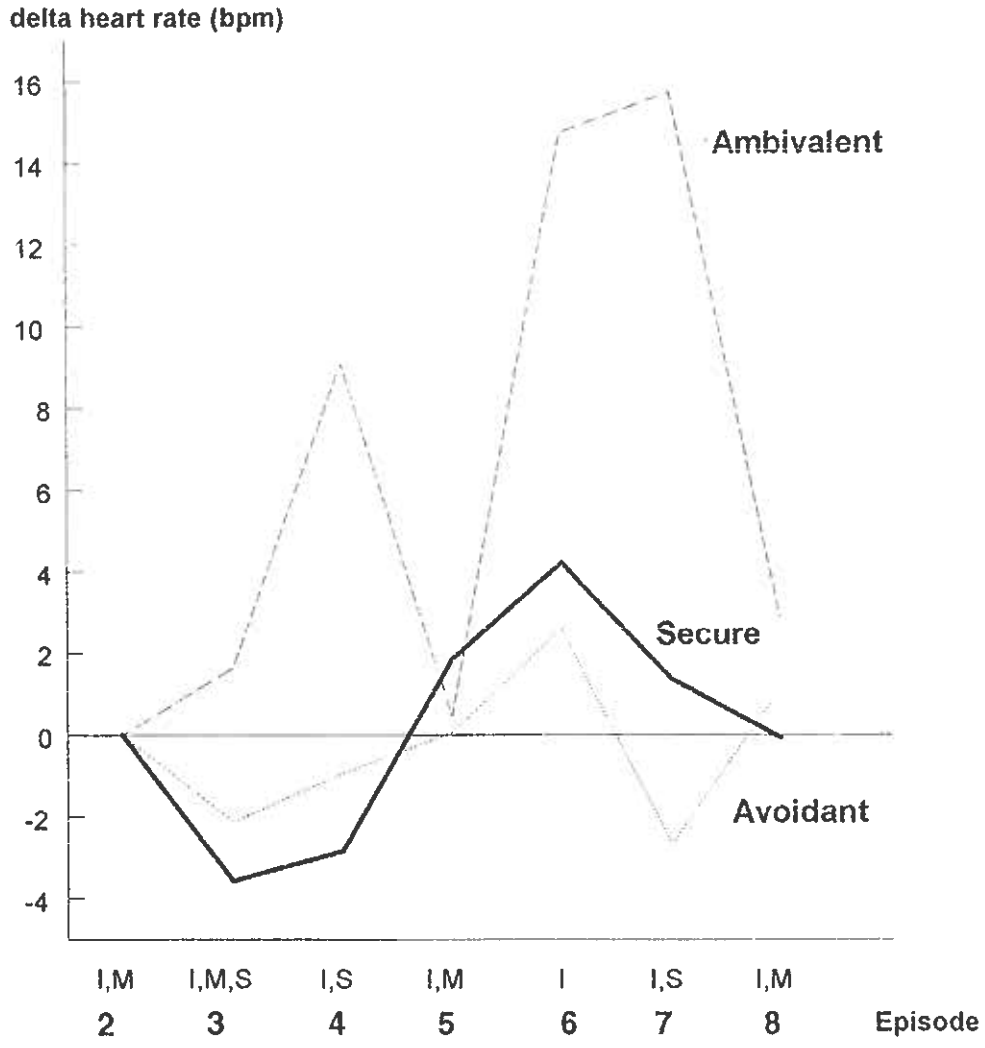

Fig.3 - Changes in infants' heart rate during the episodes for different attachment groups

Table 4. Analysis of Variance of Mothers' heart rate in terms of attachment group and episode

Source of variation	Sum of squares	d.f.	Mean square	F	Tail prob.	Greenhouse Geisser prob.
ttachment group	201.21	2	100.60	0.91	0.4	
Error	1776.26	16	111.02			
Episode	244.31	5	48.86	4.87	0.0006	0.012
Episode x Attach.	148.96	10	14.90	1.48	0.2	____
Error						

Greenhouse-Geisser epsilon factor for degrees of freedom adjustment = 0.427

Table 5. Contrasts of Mothers' heart rate between Episodes

Contrasts	Sum of squares	d.f.	F	Tail prob.
Episode 3 vs Episode 4	41.53	1	16.4	0.0009
Episode 4 vs Episode 5	2.44	1	0.26	0.6
Episode 5 vs Episode 6	16.04	1	1.16	0.3
Episode 6 vs Episode 7	2.31	1	0.61	0.5
Episode 7 vs Episode 8	135.13	1	8.82	0.009

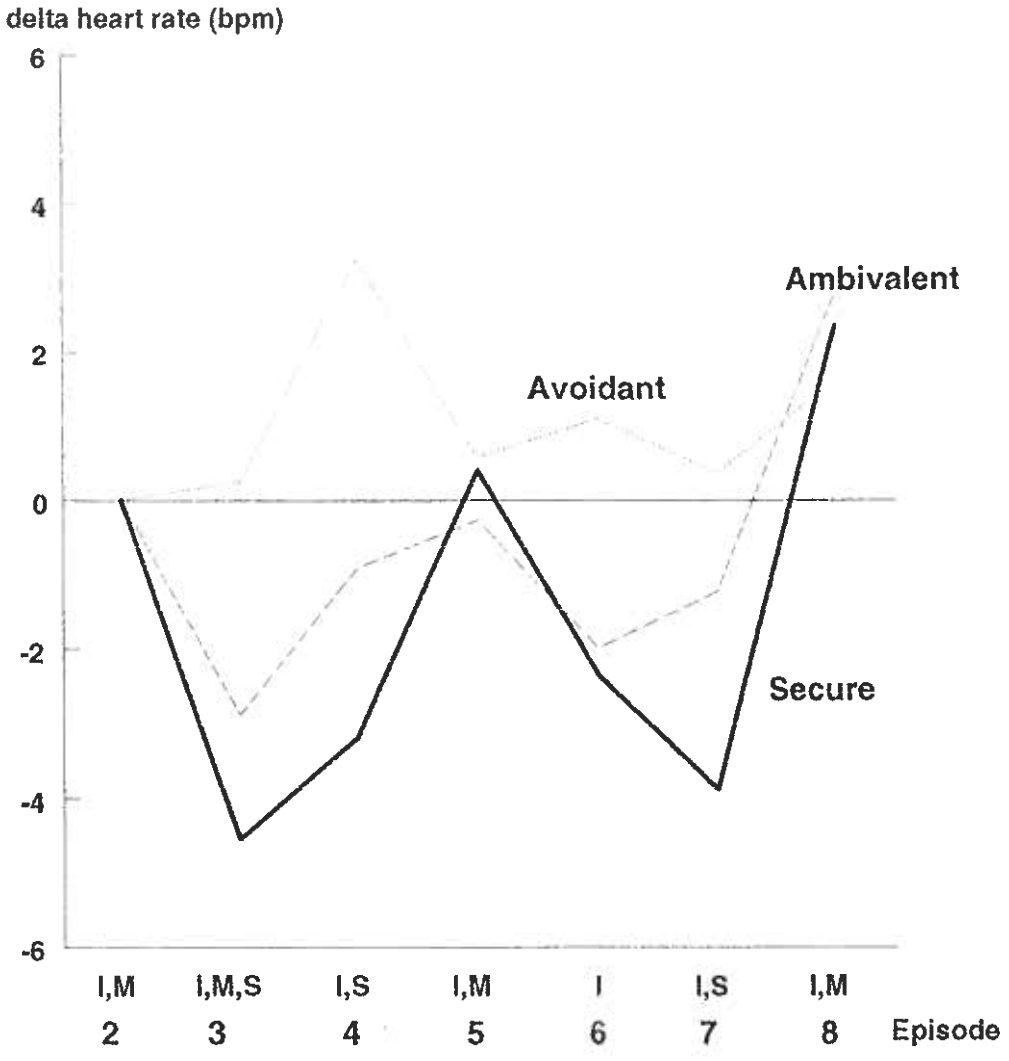

Fig.4 - Changes in mothers' heart rate during the episodes for different attachment groups