

La memoria cardiaca

Lettura dedicata al Prof. G. Morace



Prof. Luigi Padeletti

Università degli Studi di Firenze

Crotone, 5 ottobre 2012

*“Non ex omní
ligno Mercuríus”*

Pitagora

Riportata da Apuleio nell'Apologia





Effect of isoproterenol on the "early repolarization" syndrome

Giorgio Morace, M.D.

Luigi Padeletti, M.D.

Maria C. Porciani, M.D.

Fabio Fantini, M.D.

Florence, Italy



Early repolarization variant: Epidemiological aspects, mechanism, and differential diagnosis

Andrés Ricardo Pérez Riera¹, Augusto Hiroshi Uchida², Edgardo Schapachnik³, Sérgio Dubner⁴, Li Zhang⁵, Celso Ferreira Filho⁶ and Celso Ferreira⁷

19. Madias JE. Early repolarization associated with accelerated atrioventricular conduction (short PR interval) and incomplete right bundle branch block: postulated mechanisms. *J Electrocardiol*, 2007; 11 [Epub ahead of print].
20. Perez Riera AR, Schapachnik E. The Characteristic Vectorcardiogram of Patients with Brugada Syndrome. *Annals of the American College of Cardiology*, 2007; 49 (Suppl 1): 100A. Session 100A.
21. Meo J, Lelli PG. Pathophysiology of Brugada syndrome: depolarization disorder, repolarization disorder, or more? *Cardiovasc Res*, 2005; 67: 371–378.
22. Letourmy KP, Efremidis M, Pappas LK et al. Early repolarization syndrome: is it always benign? *Int J Cardiol*, 2007; 114: 390–392.
23. Morace G, Padeletti L, Porciani MC. Effect of isoproterenol on the “early repolarization” syndrome. *Am Heart J*, 1979; 97: 343–347.

23. Morace G, Padeletti L, Porciani MC. Effect of isoproterenol on the “early repolarization” syndrome. *Am Heart J*, 1979; 97: 343–347.

Electrocardiographic Changes Subsequent to Artificial Ventricular Depolarization

KANU CHATTERJEE, ALAN HARRIS, GEOFFREY DAVIES, AND
AUBREY LEATHAM

From the Cardiac Department, St. George's Hospital, London S.W.1

Brit. Heart J., 1969, 31, 770.

AUGUST 1982

The American Journal of **CARDIOLOGY**[®]

VOLUME 50

NUMBER 2

CLINICAL STUDIES

Electrotonic Modulation of the T Wave and Cardiac Memory

MAURICIO B. ROSENBAUM, MD, FACC
HORACIO H. BLANCO, MD
MARCELO V. ELIZARI, MD, FACC
JULIO O. LAZZARI, MD
JORGE M. DAVIDENKO, MD

Buenos Aires, Argentina

Alterations in the sequence of ventricular activation (left bundle branch block occurring spontaneously or induced by atrial pacing; right ventricular pacing) were studied and shown to induce two opposite changes in the order of ventricular repolarization. One, which causes classic secondary T wave changes, occurs and disappears instantaneously, and is proportional in magnitude to the QRS complex but of opposite direction. The other, which requires a long time to reach its maximal effect and to be dissipated, shows the same direction as the abnormal QRS forces but becomes apparent only when normal activation is restored. The former

La memoria cardiaca

è una particolare forma di rimodellamento elettrico:

è lo sviluppo, per effetto di una attivazione cardiaca anomala, di modificazioni nella configurazione dell'onda di ripolarizzazione

che persistono anche dopo la ripresa della normale attivazione miocardica.

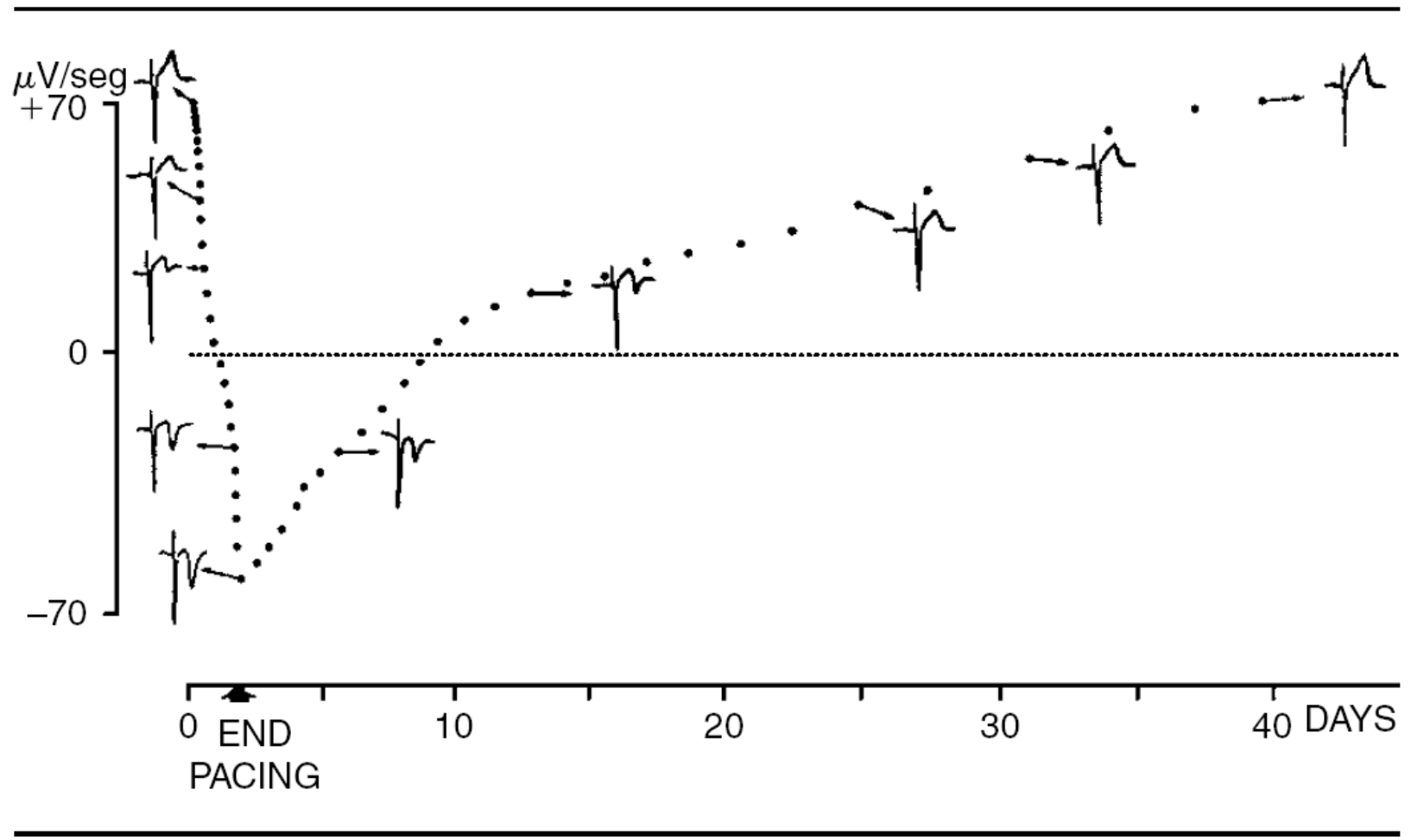


Il concetto di memoria cardiaca è stato introdotto da Rosenbaum *et al.* nel 1982 per descrivere la presenza di:

1. una onda T il cui vettore si avvicina, durante il ritmo sinusale, al vettore del complesso QRS stimolazione-indotto
2. un incremento nell' ampiezza della variazione dell'onda T (*accumulation*) a seguito di ripetuti episodi di attivazione ventricolare anomala
3. la persistenza delle modificazioni dell'onda T dopo la ripresa nel ritmo sinusale



Remodeling of repolarization in ventricle





Why T waves change: A reminiscence and essay

Michael R. Rosen, MD

References

1. Wilson FN, Finch R. The effect of drinking iced-water upon the form of the T deflection of the electrocardiogram. Heart 1923;10:275–278.

primary and secondary T wave



Why T waves change: A reminiscence and essay

Michael R. Rosen, MD



Mauricio Rosenbaum (1921–2002)

- ✓ a change in T wave that appeared at first to be **secondary** (as it was initiated by a change in the QRS complex)
- ✓ but persisted long after the QRS had normalized, such that it mimicked a **primary** change.
- ✓ Rosenbaum and associates referred to such T wave as **pseudoprimary** and- given the property of the persistent T waves to follow the vector of the inciting QRS complex called the phenomenon "**cardiac memory**"



Review

The heart remembers

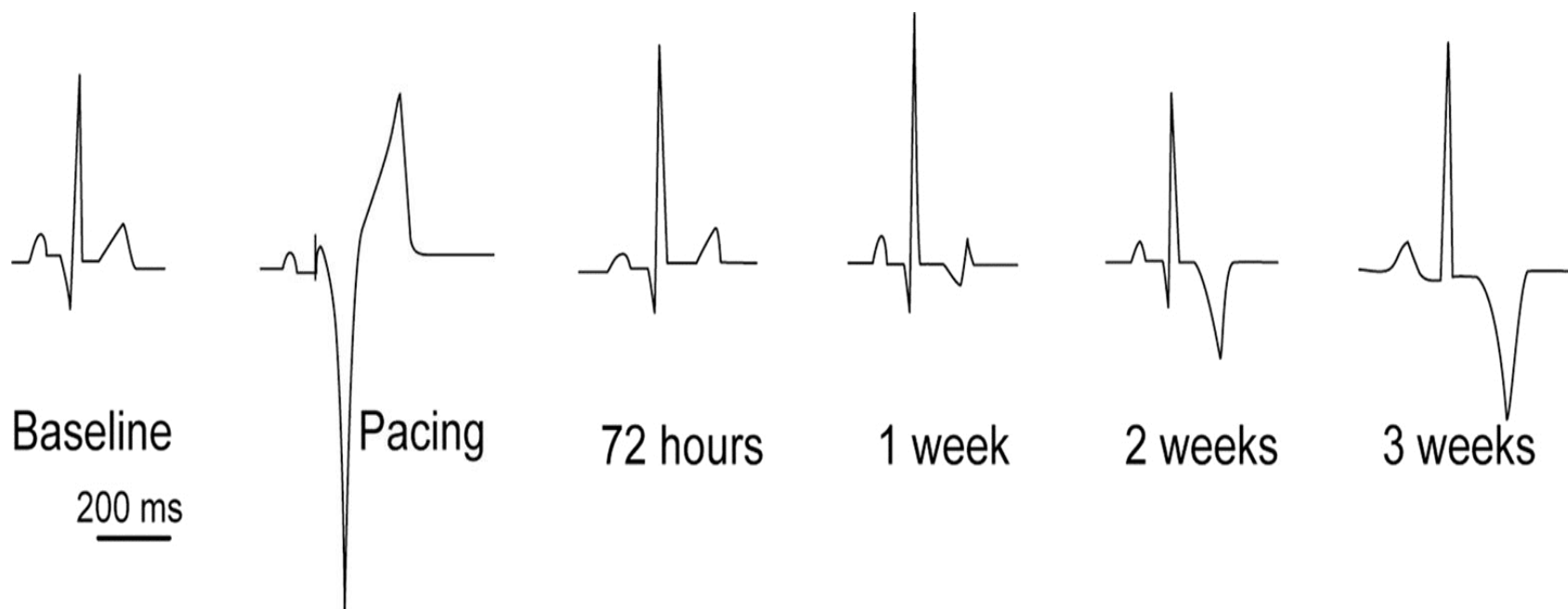
Michael R. Rosen^{a,b,*}, Ira S. Cohen^d, Peter Danilo Jr.^a, Susan F. Steinberg^{a,c}

Exploration of the mechanisms for cardiac memory is important clinically as the phenomenon (1) is induced not only by pacing, but by the occurrence of spontaneous ventricular premature depolarizations or tachycardias

(2) impacts on the determinants of ventricular repolarization and refractoriness and, therefore, potentially on the expression (or prevention) of arrhythmias; (3) can be confused with the ST-T wave changes of ischemia and (4) induces changes in ion channel physiology that are also seen with cardiac failure or that follow an ischemic insult.

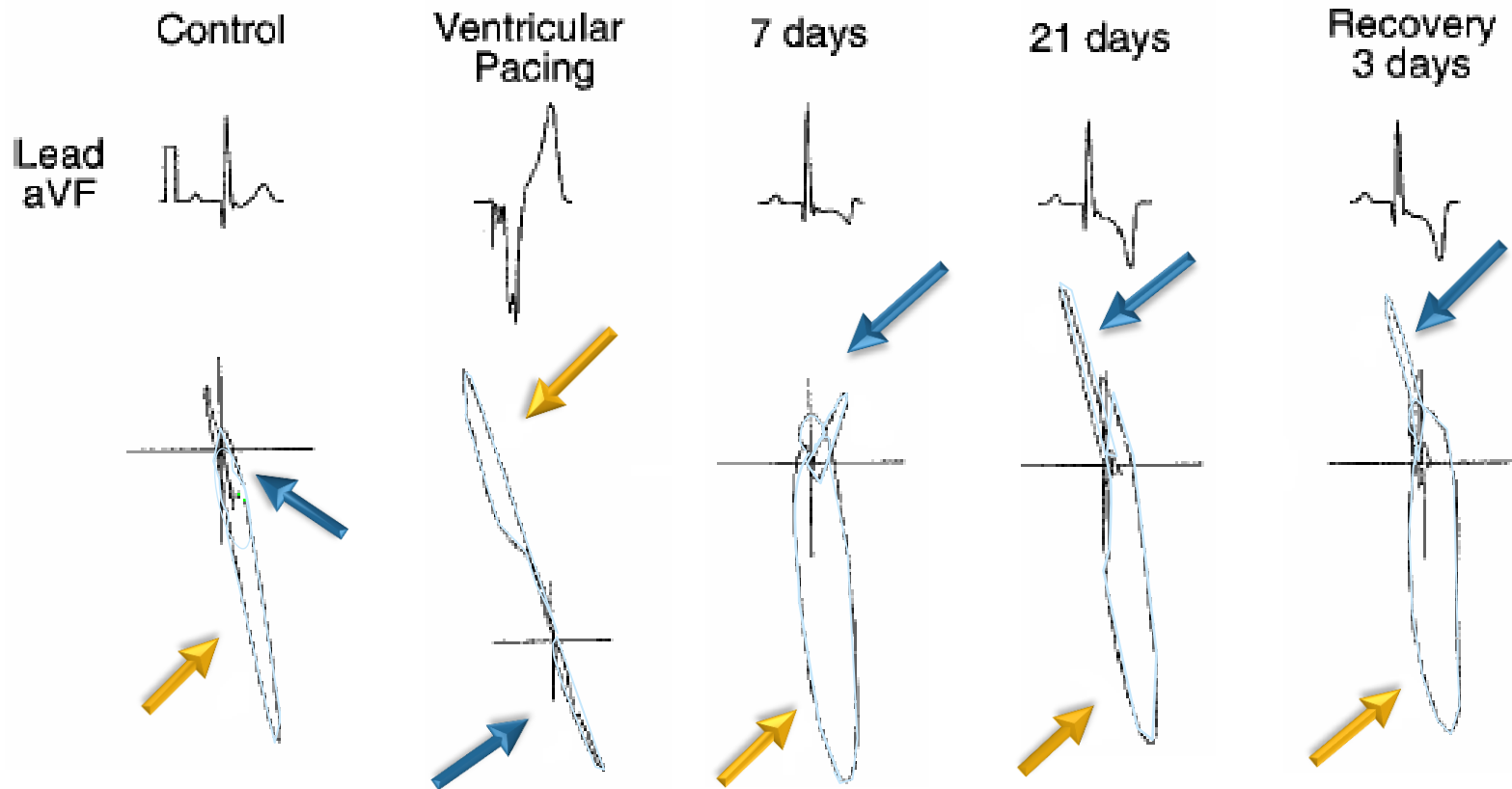




Evoluzione elettrocardiografica della memoria cardiaca





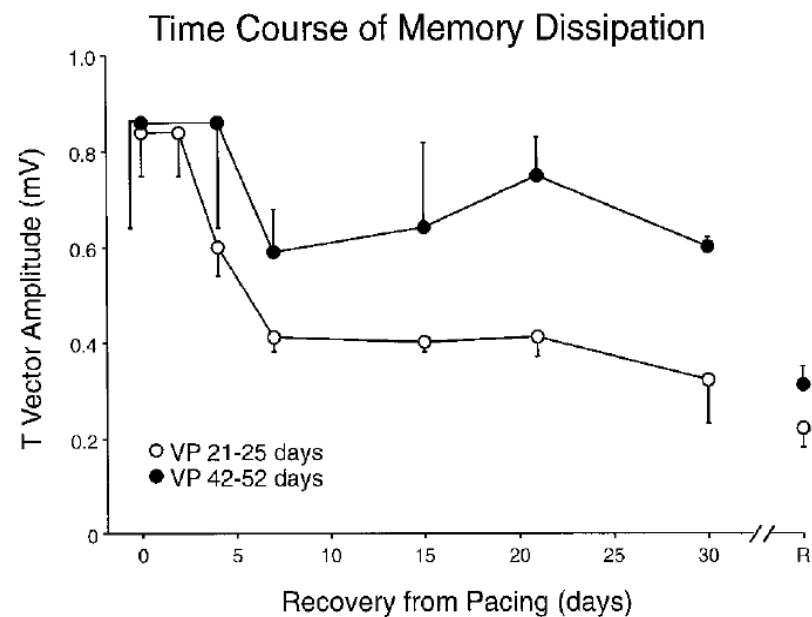
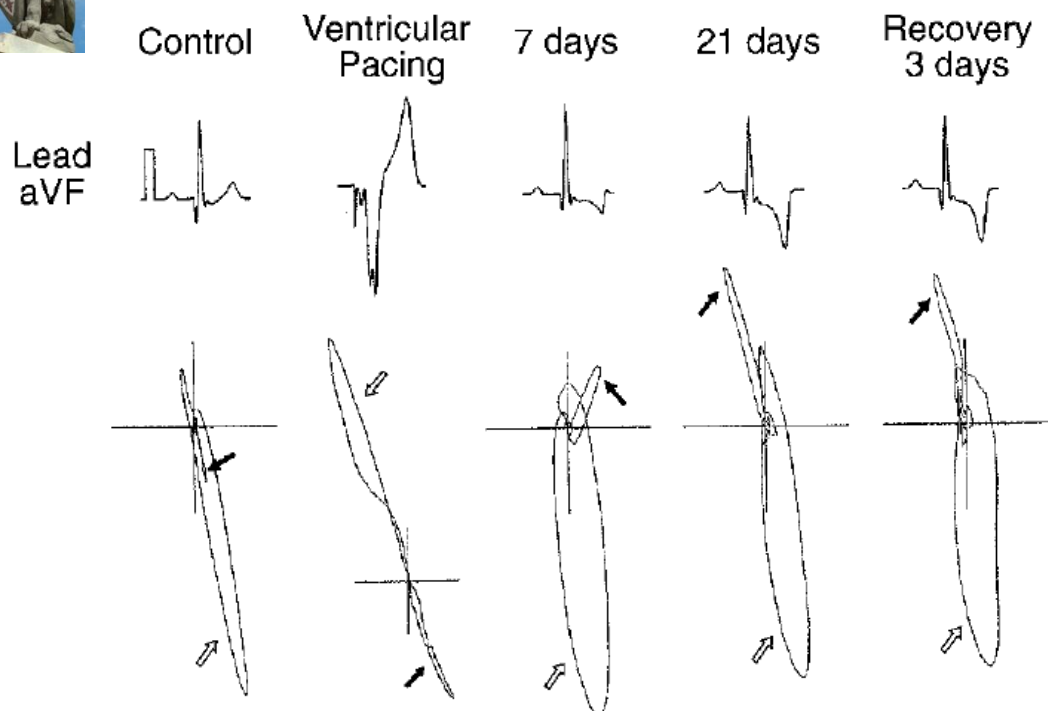
Evoluzione vettorcardiografica della memoria cardiaca



 Ansa T
 Ansa QRS

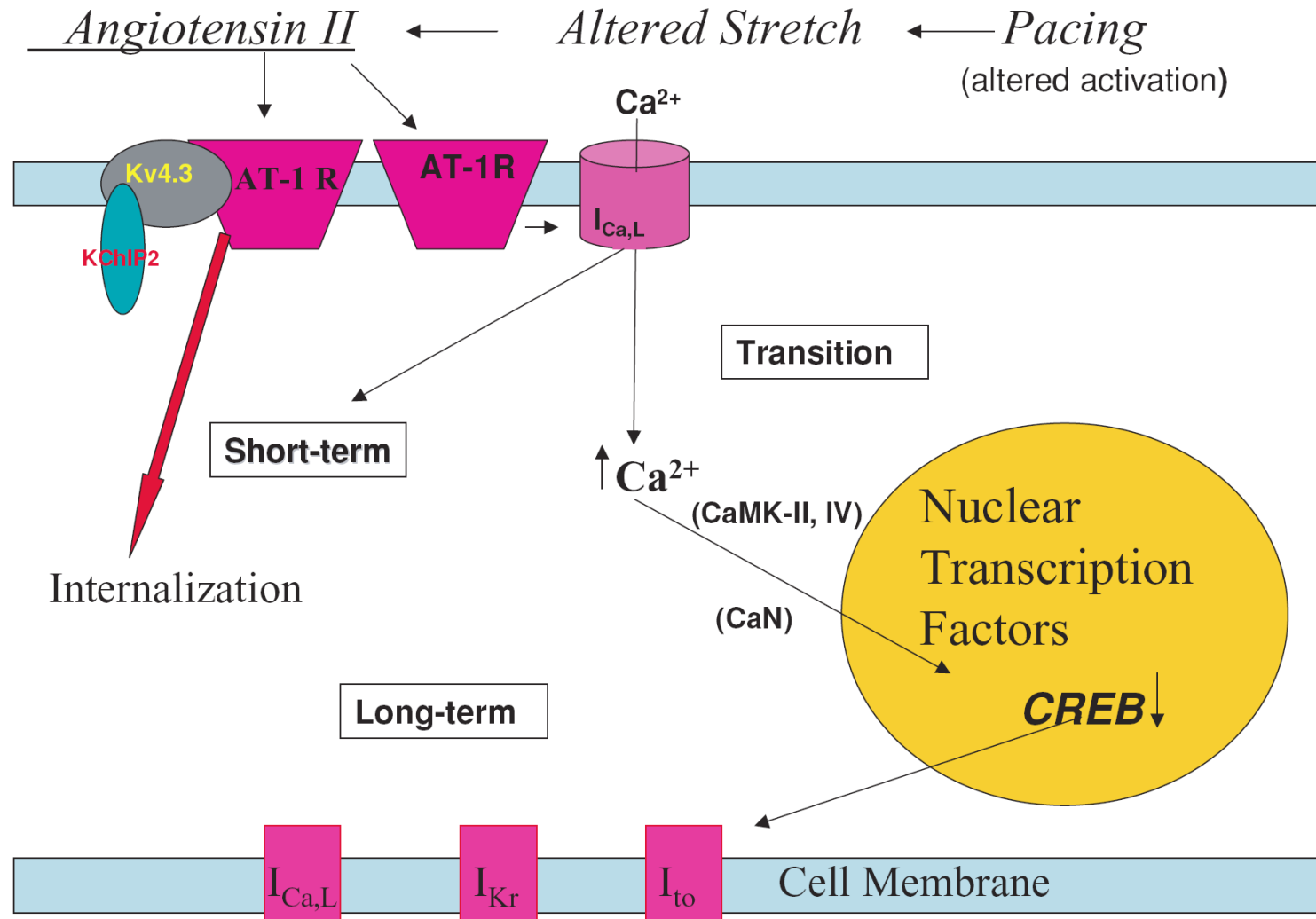


Accumulation of Cardiac Memory

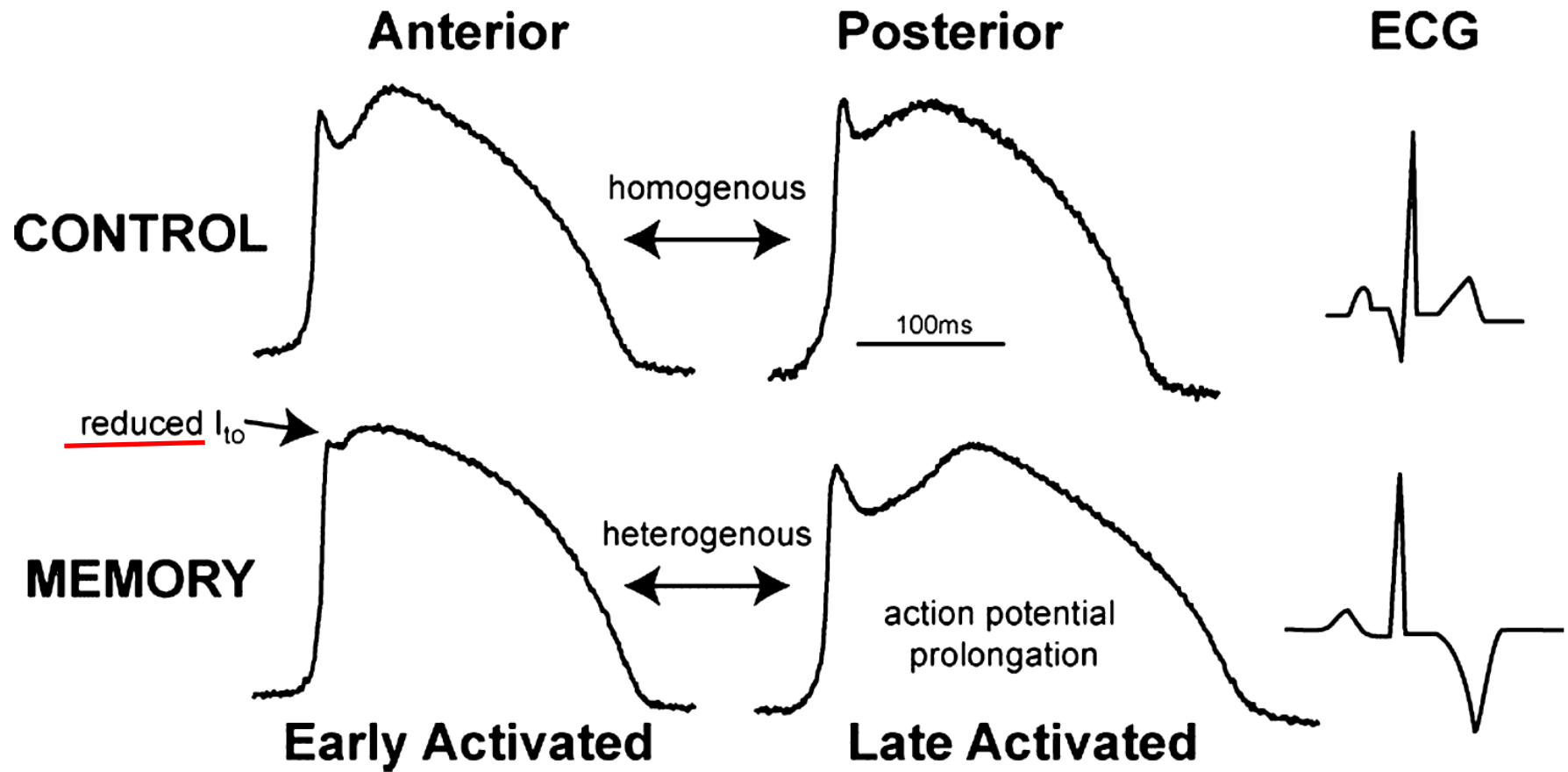




Memory in the Heart



Action Potential Remodeling in Cardiac Memory

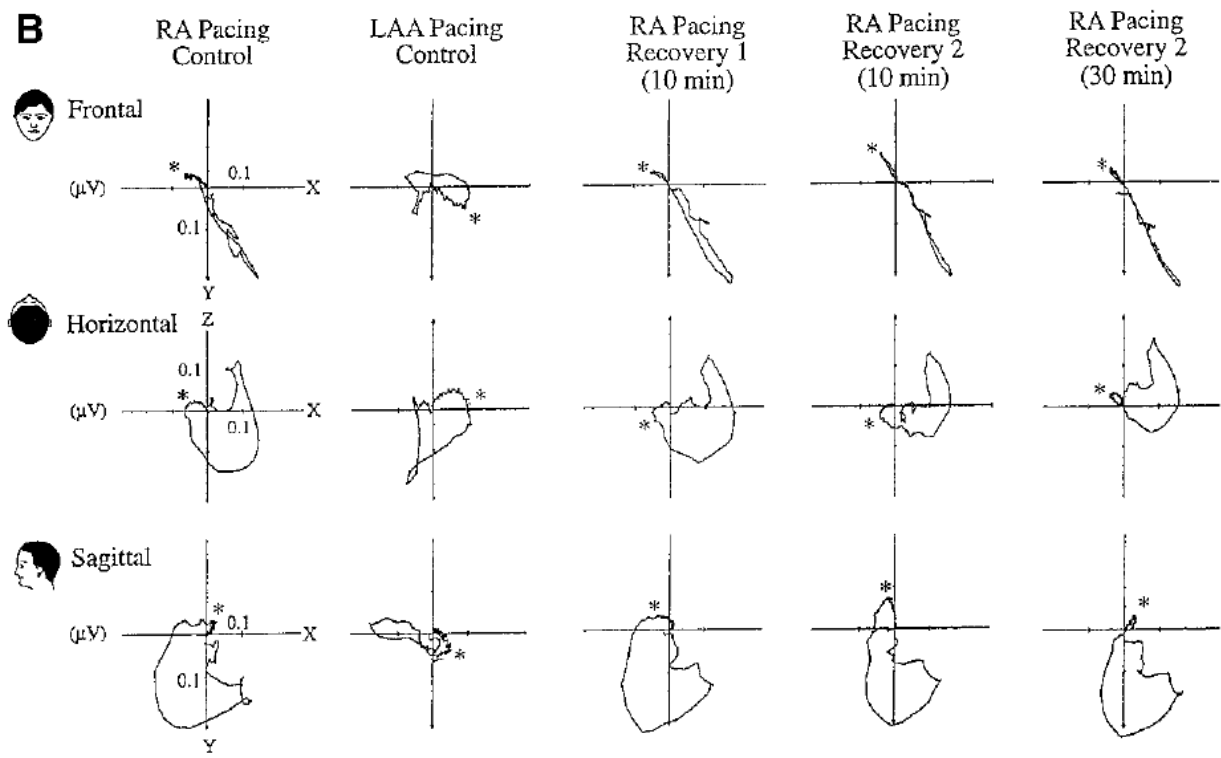




Cardiac memory in atrium

Cardiac Memory in Canine Atrium Identification and Implications

Bengt Herweg, MD*; Fang Chang, PhD, MD*; Parag Chandra, MD;
Peter Danilo, Jr, PhD; Michael R. Rosen, MD





Left atrial pacing induces memory and is associated with atrial tachyarrhythmias

Parag Chandra, Tove S. Rosen, Bengt Herweg¹, Peter Danilo Jr., Michael R. Rosen*

Changes in atrial gradient

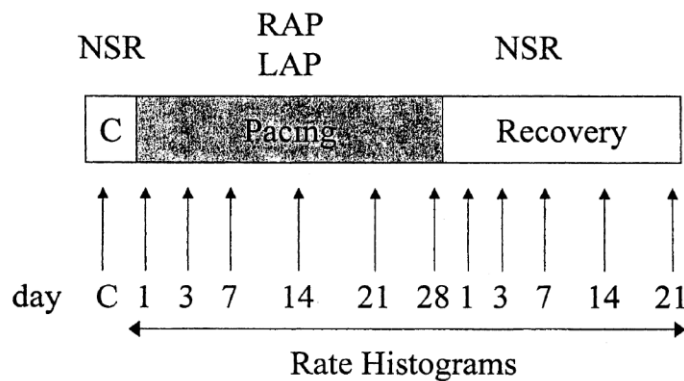
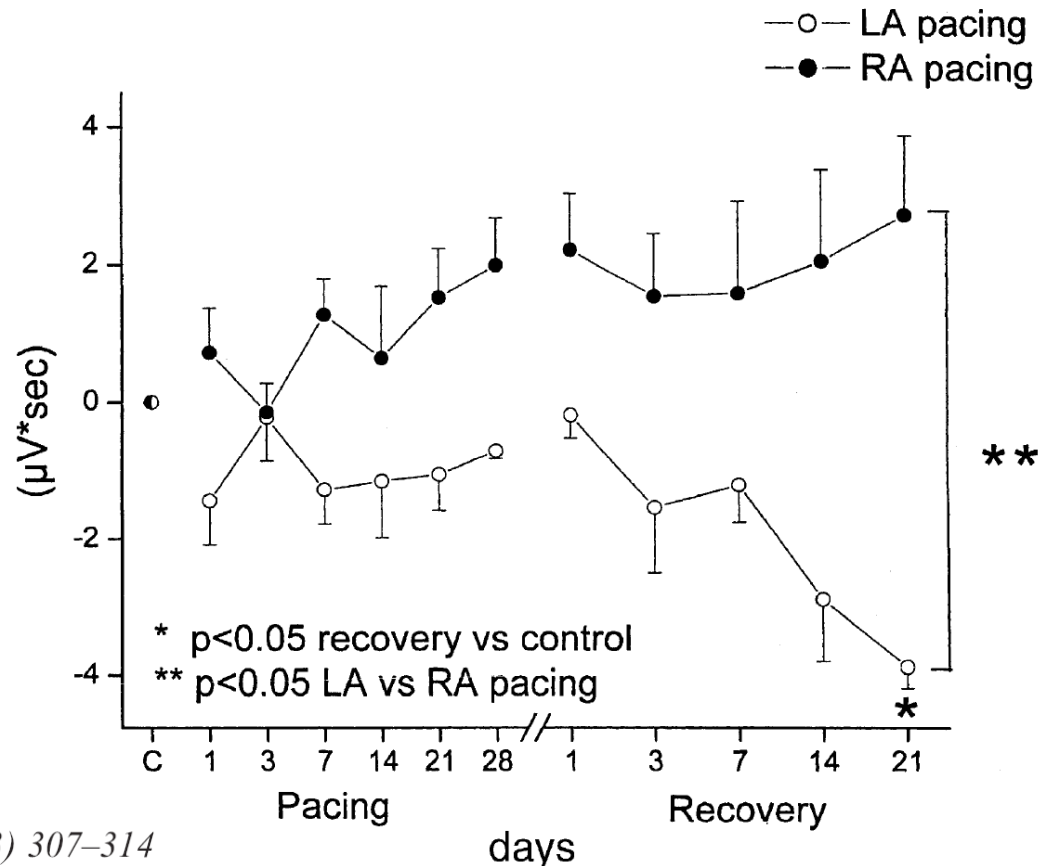
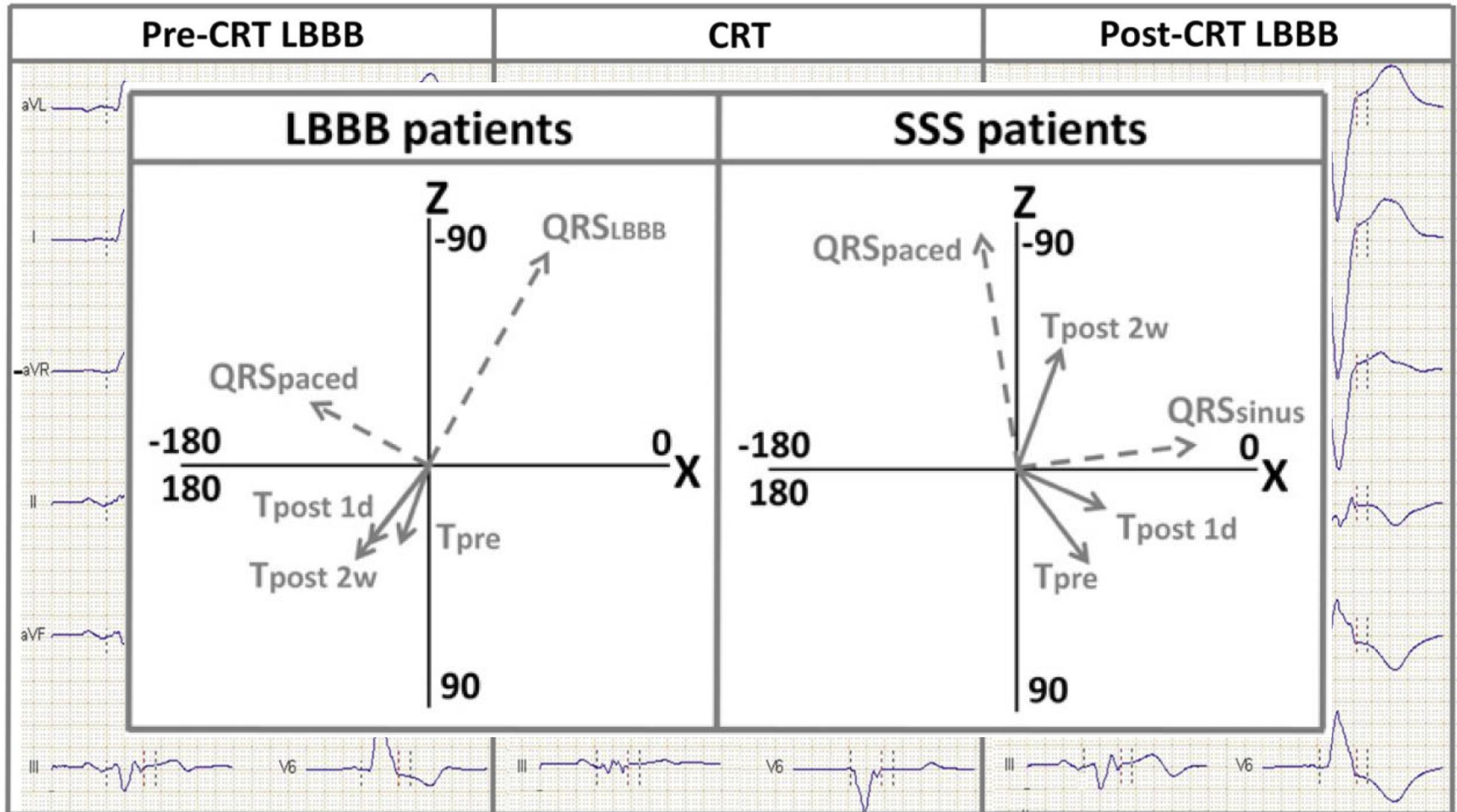


Fig. 1. Experimental protocol. ECG recordings and ERP measurements were made on the days marked with arrows in four LAA and four RAA paced dogs. Rate histograms were recorded throughout the protocol. During control and recovery animals were in sinus rhythm. C, control; RAP and LAP, right and left atrial pacing, respectively.



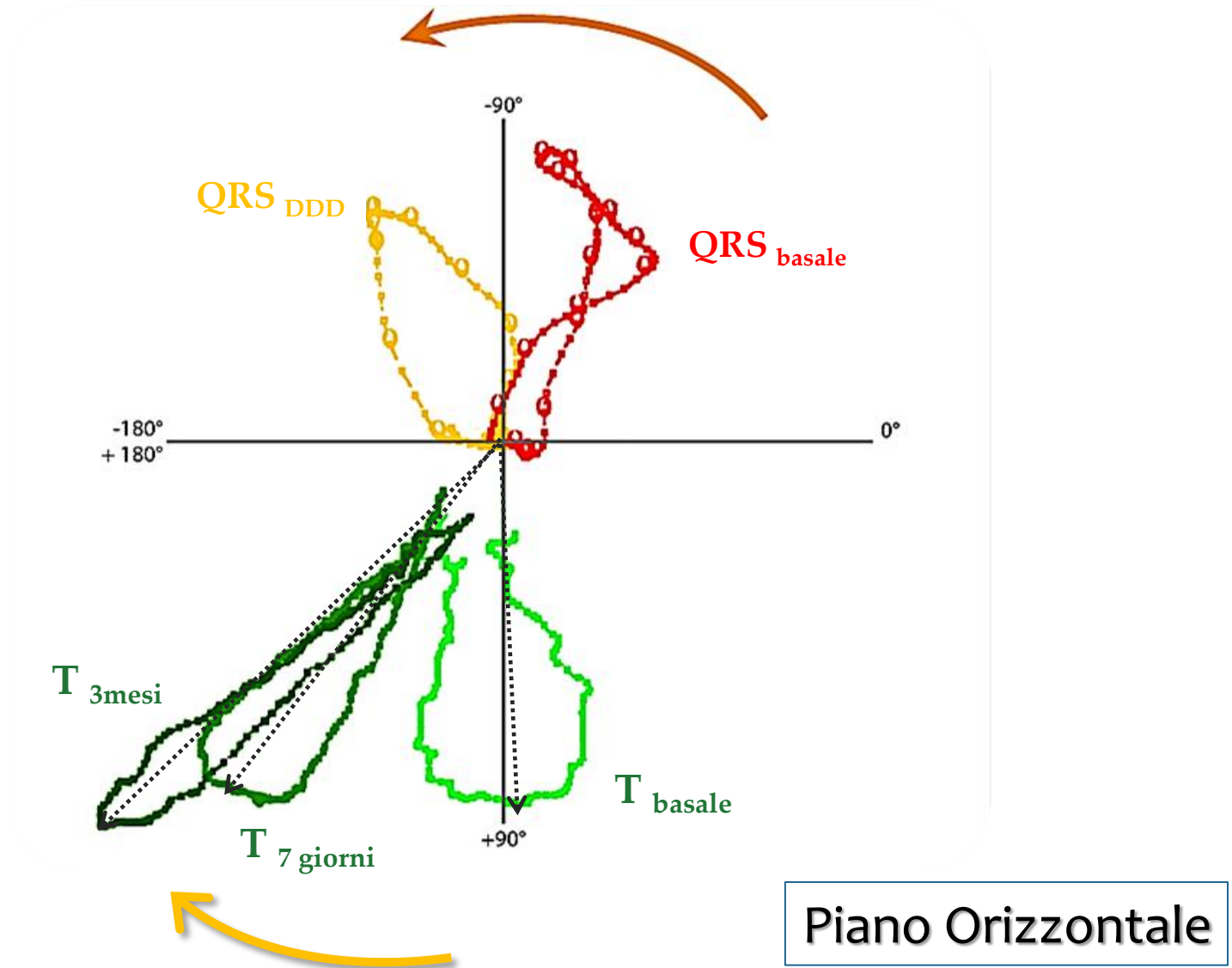
Repolarization changes in patients with heart failure receiving cardiac resynchronization therapy—signs of cardiac memory[☆]

Liliane Wecke, MD, PhD, MSc,^{a,b,*} Caroline J.M. van Deursen, MD,^a
Lennart Bergfeldt, MD, PhD,^c Frits W. Prinzen, PhD^a





Cardiac memory in humans: vectocardiographic quantification in cardiac resynchronization therapy





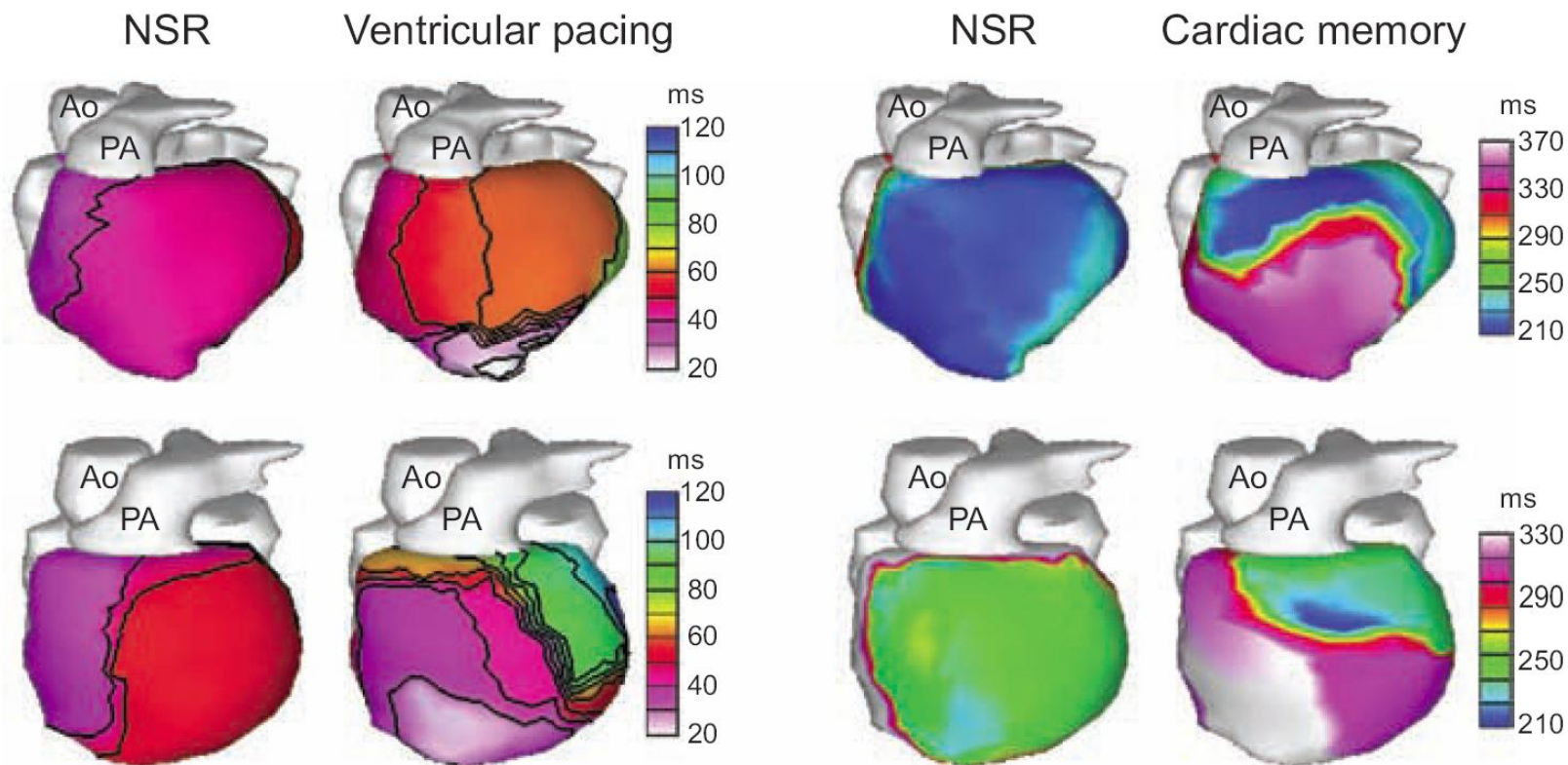
Repolarization Changes Underlying Long-Term Cardiac Memory Due to Right Ventricular Pacing

Noninvasive Mapping With Electrocardiographic Imaging

Scott B. Marrus, MD, PhD; Christopher M. Andrews, BS; Daniel H. Cooper, MD; Mitchell N. Faddis, MD, PhD; Yoram Rudy, PhD

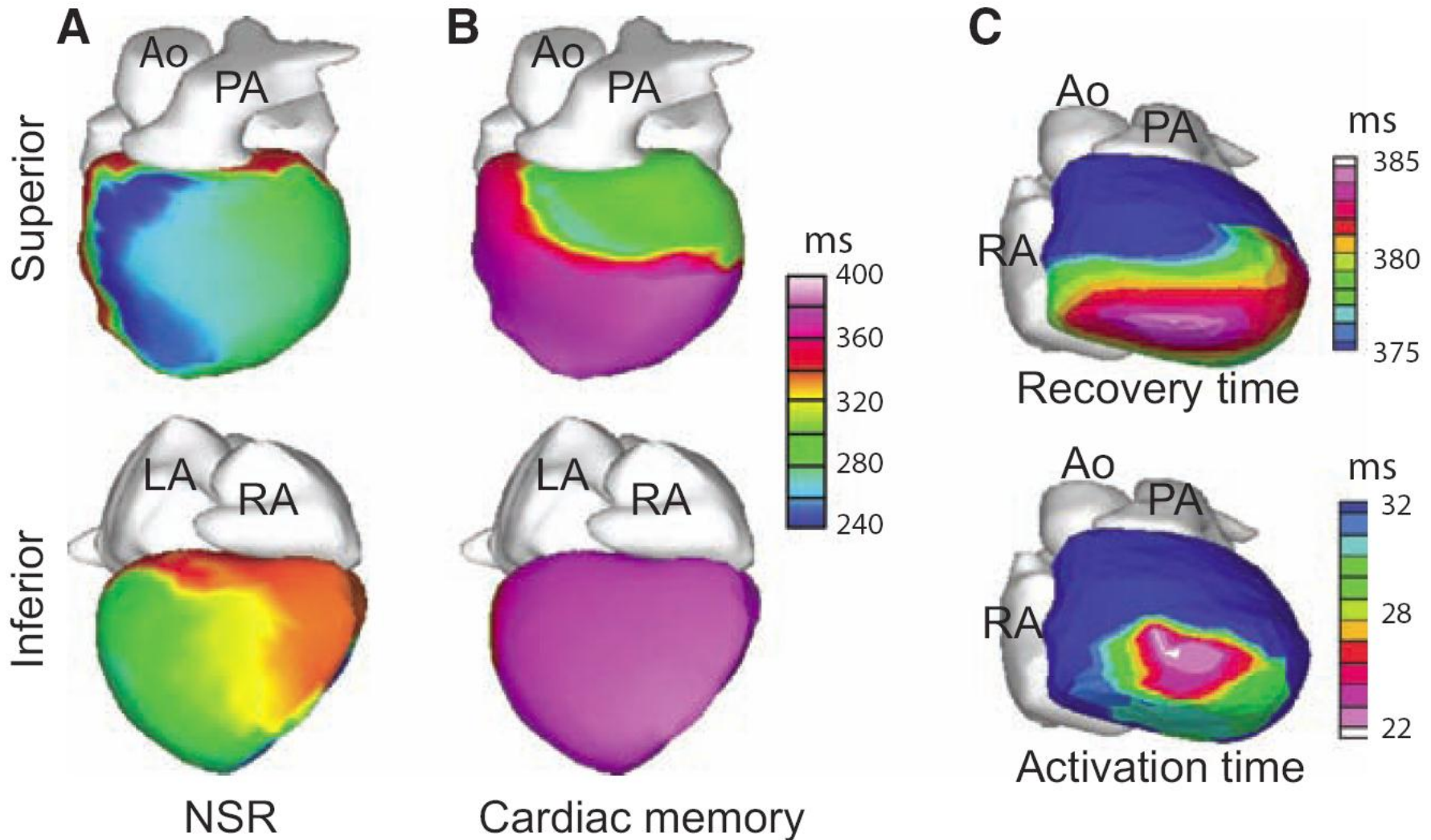
Activation time

Activation-recovery interval

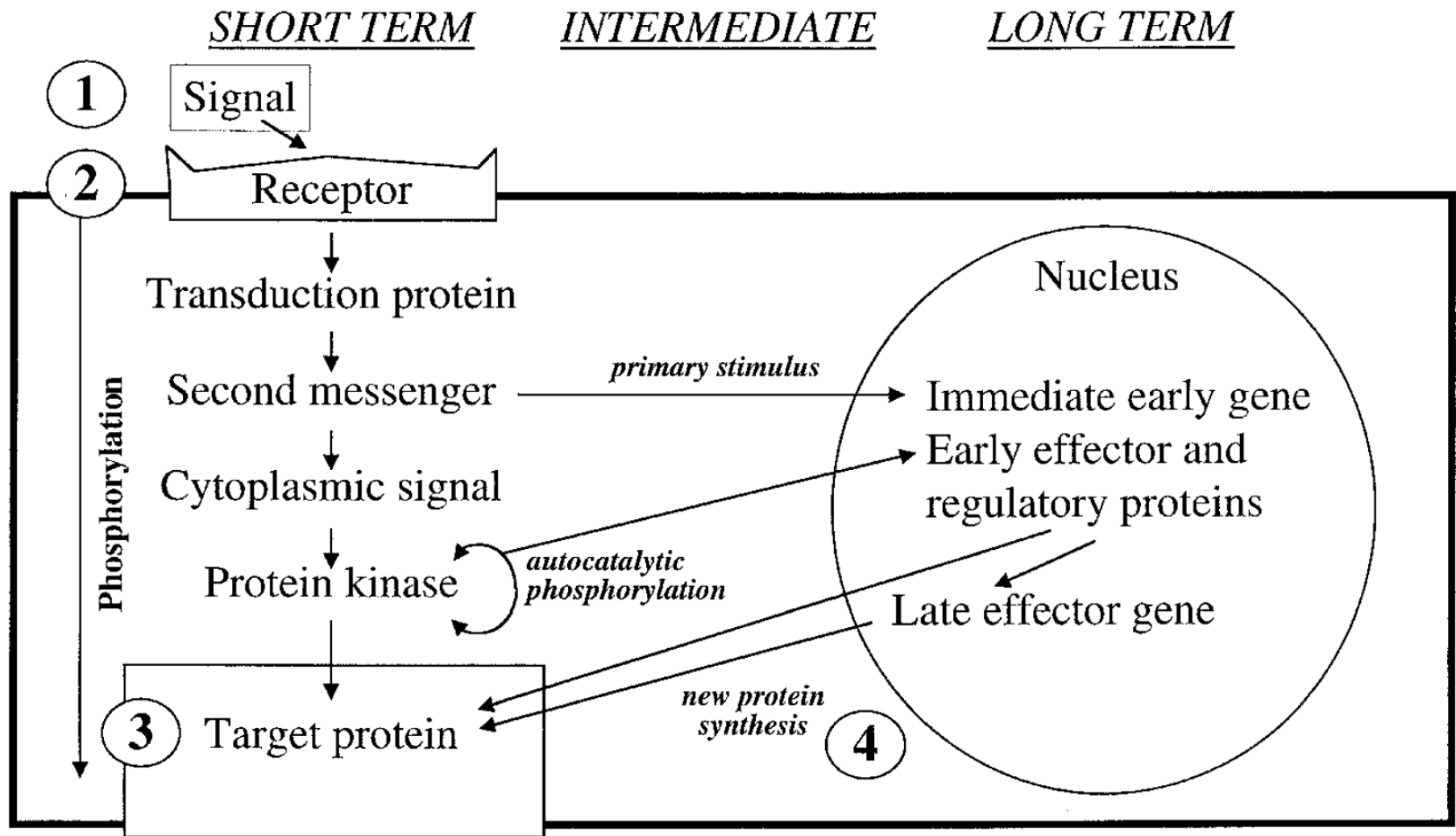




Epicardial recovery times

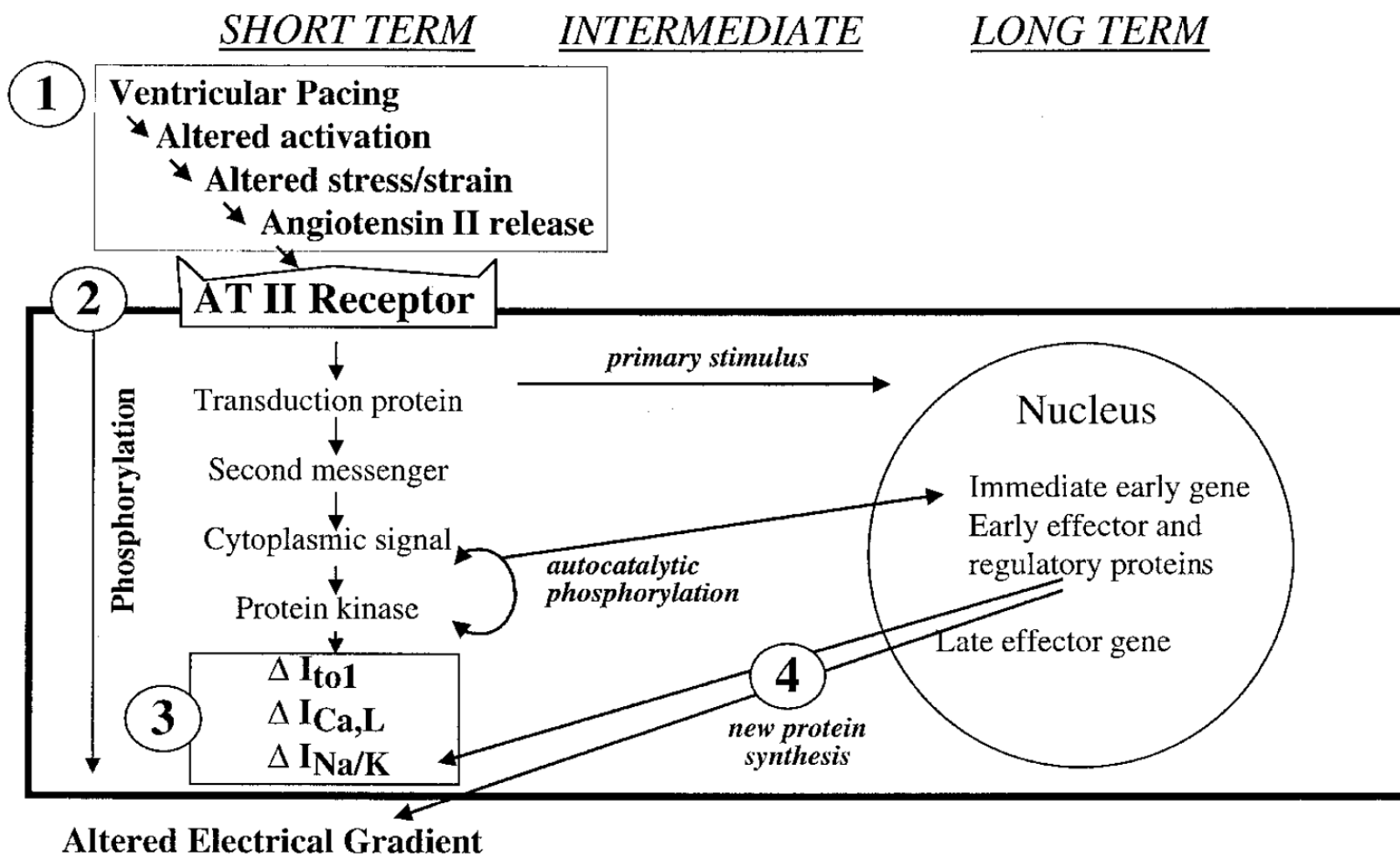


Memory in the Central Nervous System





Memory in the Heart





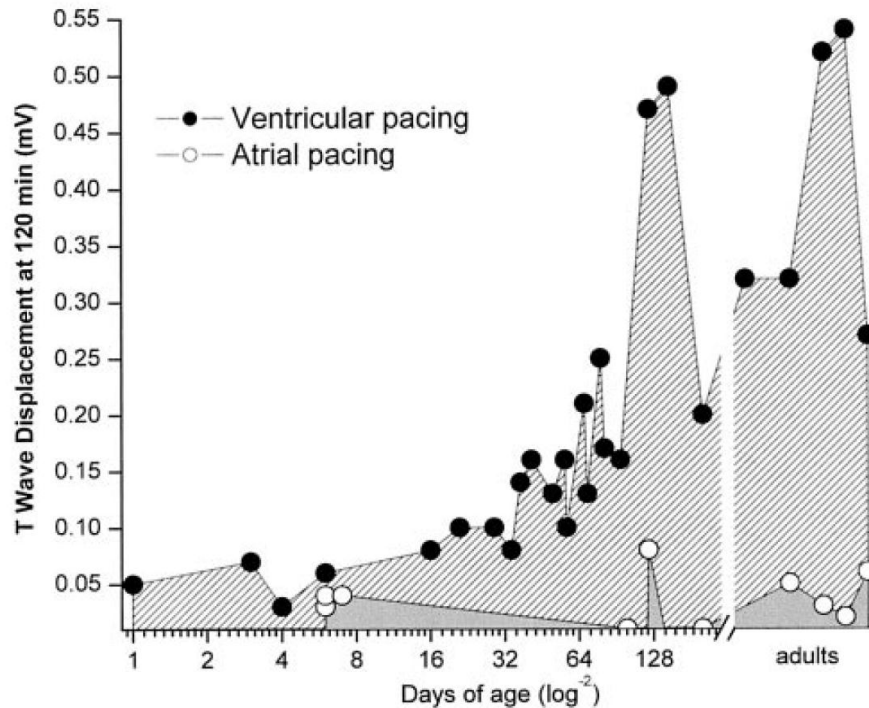
Memory in heart involves two processes:

- ✓ the “**forgetting**” of a current state of repolarization
- ✓ the “**remembering**” of a neonatal repolarization pattern.

This was uncovered by Plotnikov et al. in a study of neonatal, young, and adult dogs.

The neonate has **no Ito**, no action potential notch, and no pacing-induced cardiac memory.

At approximately 6 weeks of age, Ito, the notch, and inducible memory evolve, and with advancing age and a larger Ito, memory is ever more inducible.




The memory pattern in the adult is, in many ways, reminiscent of a neonatal heart with no Ito.



“Cardiac Memory”

A Struggle Against Forgetting

Eduardo J. Folco, Karim Roder, Gary F. Mitchell, Gideon Koren



*La memoria del cuore
si chiama gratitudine*

*Jean B. Massieu
(1772–1846)*