Background: Habituation & Self-Regulation

- Habituation (boredom at repeated stimulus) reflects learning:
  - Varies among infants
  - Controversy exists: nature, meaning, source
- Systems perspective:
  - Multiple distal and proximal forces mutually influence origins, status, growth of habituation
- Performance in habituation tasks must reflect self-regulatory processes that support appropriate responses to environment, i.e.,
  - Psychological processes: cardiac reactivity; executive attention
  - Underlying neurophysiological substrates
- Habituation efficiency would combine
  - Individual differences component
  - Time-locked organismic component
- When child can self-regulate, habituation efficiency improves

Self-regulation & attention

- Processes are complex neurophysiological system
  - Continuous feedback between central nervous system and autonomic nervous system influences
- Porges four-level hierarchical model of physiological self-regulation involving regulation of homeostatic processes from cardiac to facial expressions
- Polyvagal Theory: neuroanatomical/neurophysiological justifies looking to autonomic measure of cardiac vagal tone to index self-regulation
  - V (Vagal), NA (nucleus ambiguus): central vagal complex
  - Vna are inhibitory: slowing heart & modulating sympathetic influences
  - Under stress: vagal brake withdrawn, CVT declines
  - Facilitates rapid engagement/disengagement with changing environment
  - Infants with higher baseline Vna show
    - More novelty responsiveness
    - Shorter visual fixations
- Vagal withdrawals lead to heart rate increase to support enhanced metabolic, cognitive, and behavioral demands of the task

Goals

- To understand role of physiological self-regulation in habituation and test performance in early infancy:
  - Evaluate temporal relatedness of physiological regulation & habituation efficiency
  - Assess individual differences in stability of each process & predictive validity
    - within each age
    - across ages

Predictions

- Baseline $V_{na}$ will be related to measures of attention at each age
  - accumulated looking time
  - novelty responsiveness to external stimuli
- Greater suppression of Vna will be related to concurrently measured habituation efficiency
  - Indicates that vagal regulation supports information processing
- Measures of physiological regulation (baseline Vna; suppression of Vna) will predict habituation efficiency
  - Within age & across ages
  - Habituation efficiency will NOT predict Vna!

Participants

- 81 infants (equal number of boys & girls)
  - Randomly recruited from patients of private physicians (pediatricians & ob's)
  - Term and healthy at birth
  - Remained healthy through study
  - Free of known neurological or visual abnormalities
  - Middle- to upper SES levels (Hollingshead 4-factor Index)
- Seen in lab when infants were 2 and 5 months of age
- Mothers completed family description questionnaire one week before visit
  - Health
  - Demographics
- All infants who completed a task and had baseline ECG data were included in analyses
  - 81 infants at Time 1
  - 79 infants at Time 2
Procedure

- Two parts for infant:
  1. Baseline recording physiological activity
  2. Visual testing & recording of physiological activity
- Physiological activity
  - Five minutes of baseline ECG recording while mother talked and showed toy to infant
  - Measuring vagal influences to the heart originating in the nucleus ambiguus
- Two visual habituation-test tasks
  - Mother in adjacent room; infant alert and sated
  - Two sets of complex 2-dimensional geometric figures
  - One experimenter scored infant looking on-line
  - One experimenter monitored/control of collection of visual & physiological data
- Habituation:
  - Look away for 2 1 s. intervals;
  - 2 consecutive looks, each less than 50% baseline

Results

- Looking data not considered if
  - infant fussed or
  - mother interrupted testing conditions
  - Habituation criterion less than 1 second.
- At two months, 69% habituated on 1 of 2 tasks
  - No difference in gender, birth weight, SES, age, Vna baseline
  - Longitudinal analyses conducted for whole sample and for habituators only
- Correlations:
  - Significant negative r between 2-mo. baseline Vna and ALT (r = -.26, p < .05)
  - 2-mo. olds: Significant r between change Vna and ALT (r = .40, p < .01)
- Hierarchical regressions
  - Mean ALT was not stable (r = .14) from 2 to 5 months
  - For infants who habituated on one task or the other, the addition of task 1 change Vna resulted in significant R² change of .12 (F (1, 44) = 6.38, p < .05) for 5 mo. ALT
- Corrections for attenuation, change Vna predicts ALT (r = -.97) better than ALT predicts change in Vna (r = .34)

Discussion

- Baseline Vna related to ALT at both ages
  - Infants with higher baseline Vna at 2 & 5 mos. were shorter lookers overall in visual attn task
- Magnitude of suppression of Vna from baseline to visual task consistently associated with habituation efficiency
  - When infants did NOT habituate in 2 min., no relation between change Vna and ALT
- ALT not consistently stable and did not predict baseline or change Vna within age or between ages
  - Change Vna was stable across tasks within age, for habituators & nonhabitutators
  - NOT stable from 2 to 5 months of age
  - ALT & NR uncorrelated: represent independent processes
  - NR may be reflexive in young infants (depend on hippocampus)

Significance of Findings

- Consistent relation between change Vna and ALT is important; demonstrates interdependence of physiological self-regulation and efficient information processing.
- Physiological component of self-regulation plays increasingly central role in habituation efficiency as infant develops in first 6 months.
- Therefore, withdrawal of vagal inhibitory influences on heart during visual habituation likely facilitates shift of metabolic resources to support information processing, behavioral inhibition, state control