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Heart Rate Variability in Political Psychophysiology Research

What is Heart Rate Variability?

In healthy individuals, heart rate varies from heartbeat to heartbeat. Heart rate variability (HRV) is a measure of this variation in the time interval between heartbeats.

Image: Polar.com

Figure 1: Variation of beat-to-beat intervals (also called R-R intervals).

The Psychophysiology of HRV

Several genetic, psychological, and environmental factors influence HRV. Two psychophysiological factors, however, are particularly prominent:

1. The influence of the autonomic nervous system (ANS) on cardiac activity. The parasympathetic nervous system (PNS) is a branch of the ANS that rapidly adjusts heart rate in response to environmental and physiological stimuli;

2. The central autonomic network's (CAN) regulation of heart rate. More specially, the CAN supports emotional regulation; thus, it adjusts an individual's initial physiological arousal to meet changing situational demands.[1]

Simply put, HRV serves as an indicator of the automatic balance between sympathetic and parasympathetic activity. Low HRV is associated with several psychological disorders characterized by "poor emotional regulation and behavioral inflexibility"

[1] For a more through explanation of the ANS and CAN's influence on HRV, consult the "Physiological Underpinnings of HRV" section in the Appelhans et al. paper.

(Fujimura et al. 2012, 578). High HRV, on the other hand, is associated with effective emotional regulation and physiological coping responses to stress (Leon et al. 2009).

Two psychophysiological theories establish a causal link between the autonomic flexibility represented by HRV and the capacity for regulated emotional responding.

1. Porges' *Polyvagal Theory* identifies a physical link between HRV and regulated emotional responding by way of the ventral vagus complex, the neural complex associated with the tenth cranial nerve (the vagus nerve). Among other functions, the vagus nerve transmits neural information from the ANS to the heart.

   The Polyvagal Theory states that the ANS developed the capacity to respond effectively to situational demands in stages. As Porges explains, the "increased vagal action on the heart reduces cardiac output and creates a physiological state that promotes the calm behavioral profile necessary to sustain interactions with people and objects." (Porges, as cited in León et al. 2009, 7). In other words, Porges' theory claims that increased vagal output is one direct determinant of high HRV, which is subsequently associated with high capacity for regulated emotional responding.

2. Thayer and Lane's *Neurovisceral Integration Model* identifies a similar physical link between HRV and regulated emotional responding by way of the prefrontal cortex, the part of the brain that regulates and emotional cognition.

   According to the Neurovisceral Integration Model, the vagus nerve, which originates in the prefrontal cortex, evolved to rapidly respond to situational demands to support regulated emotional responding. The CAN facilitates efficient vagal regulation by inhibiting other potential neural responses from cognitive, behavioral, and physiological factors. In other words, the CAN serves as the "neurophysiological command center governing cognitive, behavioral, and physiological elements into regulated emotion states" (Appelhans and Luecken 2006, 234).

In sum, the physiological influences of HRV outlined first in this section established that HRV serves as an index for the flexibility of the autonomic nervous system. The psychophysiological theories described above specify the causal mechanism behind this: efficient vagal regulation. Vagal output, information flowing from the tenth cranial nerve, directly affects HRV.

Accordingly, several studies have shown that efficient vagal regulation correlates with effective coping responses and positive stress management strategies (Bazhenova et al., as cited in Léon et al. 2009, 7).

Measurement of HRV

While statistical software programs often provide automatic calculations of HRV derived from ECG data, a variety of HRV calculation methods exist. These different methods often do not produce comparable outputs. Furthermore, the efficacy of these methods varies from dataset to dataset. For comparable and accurate results, it is important that each researcher understand which method of HRV calculation is used by their respective software program, and furthermore that they intentionally select the method of HRV calculation that best suits the dataset.

The simplest method of HRV measurement uses an electrocardiogram (ECG), which automatically measures the mean "normal-to-normal" or R-R interval (that is, the interval between peaks in the QRS complex observed on an ECG), the mean heart rate, and the difference between the longest and shortest RR interval. Most software used to analyze physiological variables, like heart rate, will include an automatic calculation of HRV based on ECG data (Malik et al. 1996).

HRV varies, at least in part, according to environmental stimuli, so it is essential to select the appropriate period of time when using ECG data to calculate HRV. While most research usually measures baseline heart rate[2] for only a few minutes, it is worth noting that some methods of HRV calculation require continuous ECG data for up to eighteen hours so as to account for night-day changes in HRV (Malik et al. 1996).

Applying HRV in Political Psychophysiology Research

The earliest psychophysiological studies treated heart rate as a dependent variable influenced by cognitive and metabolic processes, and considered variability in beat-to-beat variance to be mere error variance attributed to poor experimental design and control (Bernston et al. 1997, 624). As methods developed, however, researchers began to recognize HRV as a meaningful psychophysiological variable in its own right.

[2] Note that research that uses HRV as an independent variable should always derive it from resting heart rate.

Researchers in political psychophysiology are beginning to consider the utility of HRV for their studies; but some confusion remains. In particular, we are unsure whether HRV would be most useful to us as an independent or as a dependent variable. Our intuition suggests that HRV should be employed in political psychophysiology studies as a dependent variable. In several of our experiments, for example, we first expose participants to politically contentious stimuli, and then measure how these stimuli affect physiological variables, such as heart rate. So, since we treat heart rate as a dependent variable and derive HRV from it, then we should treat HRV as a dependent variable too, right?

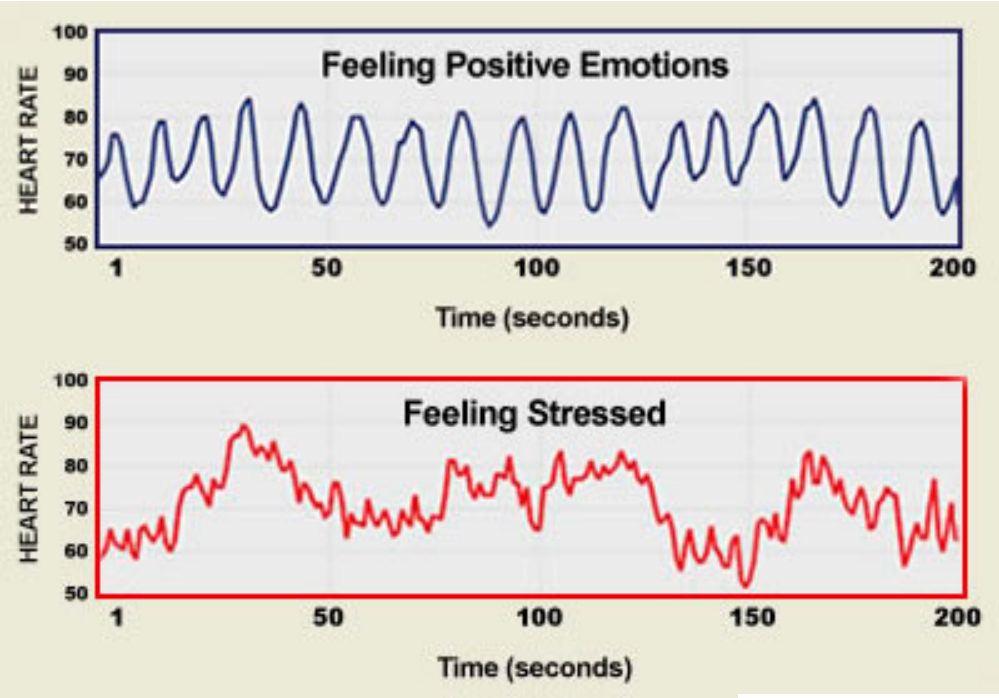

Image: Willow Cottage Clinic

Figure 2: Heart Rate as an independent variable

Well, no; the literature on HRV suggests otherwise. Most recent studies consider HRV a descriptive variable. These studies apply one of three theoretical frameworks with regards to HRV:

1. One that treats HRV as a trait-like variable that discerns individual differences in behavioral and autonomic response;
2. One that considers it an index of cognition and mental load;
3. And one that focuses on conditioning and controlling it through biofeedback techniques (Bernston et al. 1997, 625).

Of these frameworks, the first seems to be the most applicable to political psychophysiological research. Because this framework stresses resting HRV importance as physiological indicator of an individual's capacity for regulated emotional response, it would allow political psychophysiology researchers to employ HRV to discern *how* certain individuals are likely to react to external stressors, such as politically contentious situations. But perhaps more importantly, this framework would allow us to use HRV as *a direct measure of physiological reactivity*. The descriptive variables that we currently collect – individuals' scores on the Five-Factor Personality Inventory, or the Willingness to Self-Censor Scale – serve as mere proxies for physiological reactivity. There is strong theoretical and empirical evidence, however, that HRV can serve as a direct measure – or at the very least, certainly a *more* direct measure – of physiological reactivity. In other words, we can use HRV as a descriptive variable not only to discern *how* certain individuals are likely to react to politically contentious situations, but also *why* they are likely to react the way they do.

Interpretative Caveats

While HRV is understood to be an indicator of regulated emotional response, the exact physiological and environmental factors that contribute to HRV remain largely unknown. It is therefore important to be particularly cognizant of potential confounding variables in studies employing HRV. To avoid overestimating the predictive significance of resting HRV, we should calculate HRV along with our currently employed psychological indices of regulated emotional response that measure personality and intelligence. Doing so would also allow us to observe where HRV's predictive potential of physiological reactivity overlaps with that of non-physiological descriptive variables, as well as where it either extends beyond or falls short.

References

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