Practical Polygraph: A Codex of Cardio Artifacts

Raymond Nelson

Cardiovascular activity, one of the autonomic signals of interest during polygraph testing, can potentially include a number of types of data artifacts. Artifacts, in polygraph data analysis, are unexpected patterns of activity that are inconsistent with data of normal interpretable quality. Data artifacts represent a concern to field polygraph examiners for several reasons. First, cardio data artifacts may cause ambiguity and error in feature extraction. For this reason, artifacted data segments are often excluded from analysis. A second concern, related to the first, is that cardio data that are laden with numerous artifacts may be unproductive in terms of numerical scores, and this may contribute to inconclusive test results.

Some cardio data artifacts, such as general instability and dampening, may have global effects that may also increase the likelihood of an inconclusive test result. Most types of cardio data artifacts can be assumed to be the result of involuntary causes because they cannot be reproduced voluntarily. However, some cardio data artifacts, such as physical movements, may occur due to involuntary acts, and may also be reproduced through voluntary activity. These may be of special interest to polygraph professionals because they can be subject to statistical analysis for inference as to their actual cause.

Examples of cardiovascular data artifacts

Involuntary cardio artifacts include respiratory blood pressure fluctuation, ectopic heartbeats, cardio-arrhythmia, and muscle fasciculations. Other physical movements may be either voluntary or involuntary, and are therefore of unknown cause. Common global artifacts include general instability, not associated with physical activity or phasic responses to test stimuli and dampening of phasic activity.

Table 1 shows a list of seven types of commonly observed data artifacts in recorded cardiovascular signals of polygraph examinations.

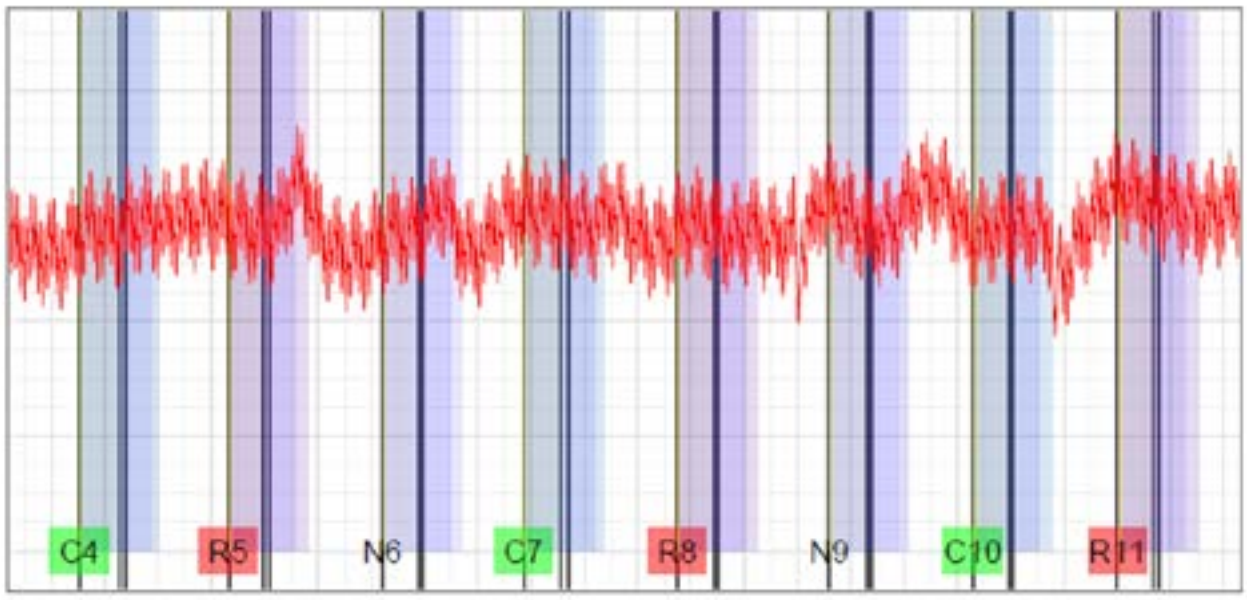
Artifact pattern	Involuntary or Unknown
Respiratory blood pressure fluctuation (RPBF)	Involuntary.
Extrasystoles (premature ventricular events)	Involuntary
Cardio-arrhythmia	Involuntary
Muscle fasciculation (involuntary movement)	Involuntary
Physical movement	Unknown
General instability	Global
Dampened/unresponsive cardio data	Global

Respiratory blood pressure fluctuation

Respiratory blood pressure fluctuation (RBPF) is shown in Figure 1. This pattern of activity has been referred to in polygraph jargon as a *vagus-roll*. It is an oscillating pattern of fluctuation in both systolic and diastolic pressure for which the frequency is observably similar to the frequency of observed respiratory cycles.

RBPF is involuntary and has not been shown to be empirically correlated with deception or truth-telling. In fact, respiratory signals are a common occurrence in cardiovascular data, and are strategically exploited by medical professionals who often use pulse-oximetry to observe and calculate respiration rates.

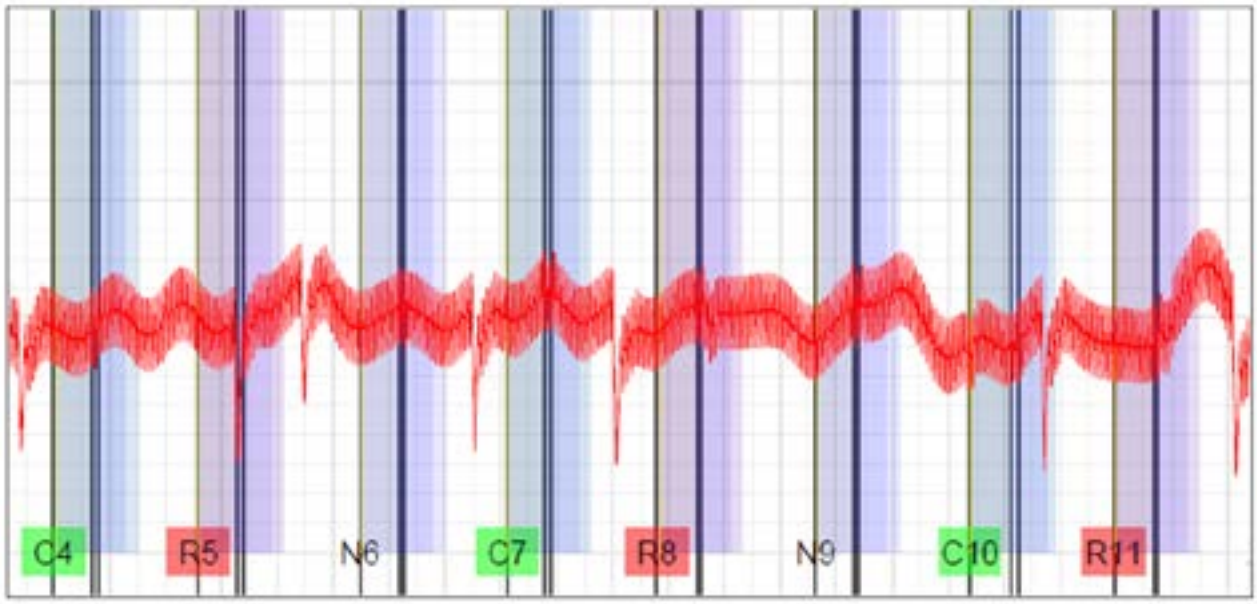
Figure 1. Respiratory blood pressure fluctuation.



Extrasystoles, ectopic heartbeats or premature ventricular contractions

Extrasystoles, also referred to as ectopic heartbeats, are observed as a distinct pattern of changes in the cardio data, consisting of an apparent skipped heartbeat followed by a drop or loss of arterial pressure and then an immediate rise or recovery of arterial pressure. Figure 2 shows an example of cardiovascular data with premature ventricular events. This pattern may be cause by premature ventricular contraction (PVC) or premature atrial contraction (PAC). Regardless of the exact mechanism or cause, ectopic heartbeats are involuntarily and cannot be produced at will.

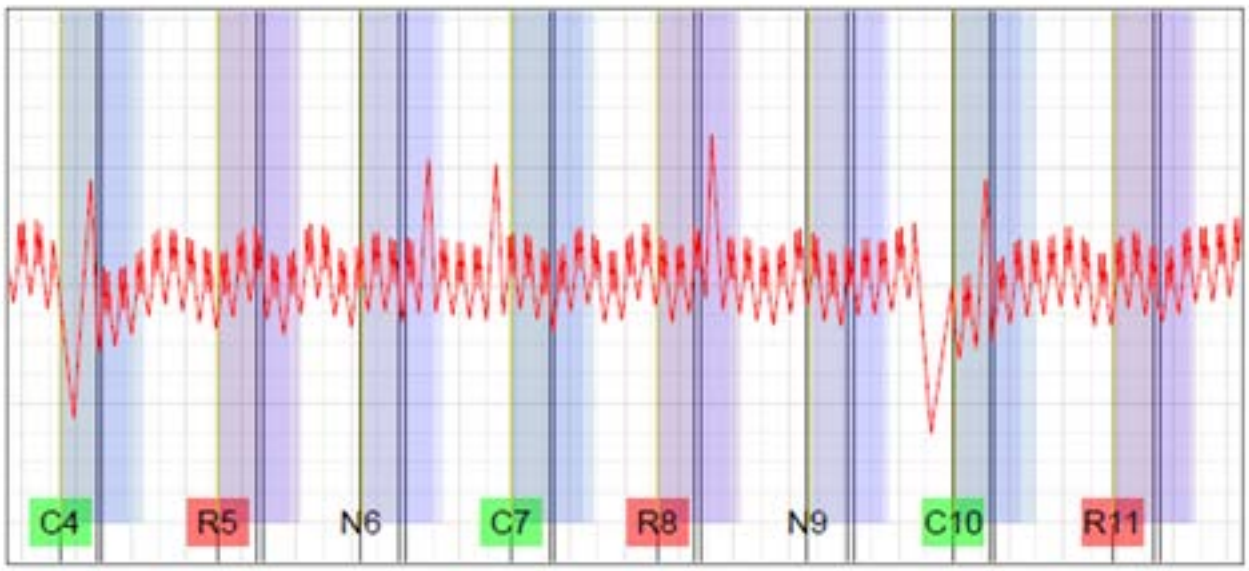
Figure 2. Ectopic heartbeats.



Cardio-arrhythmia

Cardio-arrhythmia is term that refers to patterns of irregular cardiac activity. These can occur because of involuntary irregularities in the electrical signals that initiate the cardio contractions, and also as a result of physical or congenital problems with the heart valves. Several different types of arrhythmia are described in the medical literature. An example of one type of cardio-arrhythmia is shown in Figure 3. Cardio-arrhythmia is involuntary and cannot be deliberately reproduced or induced.

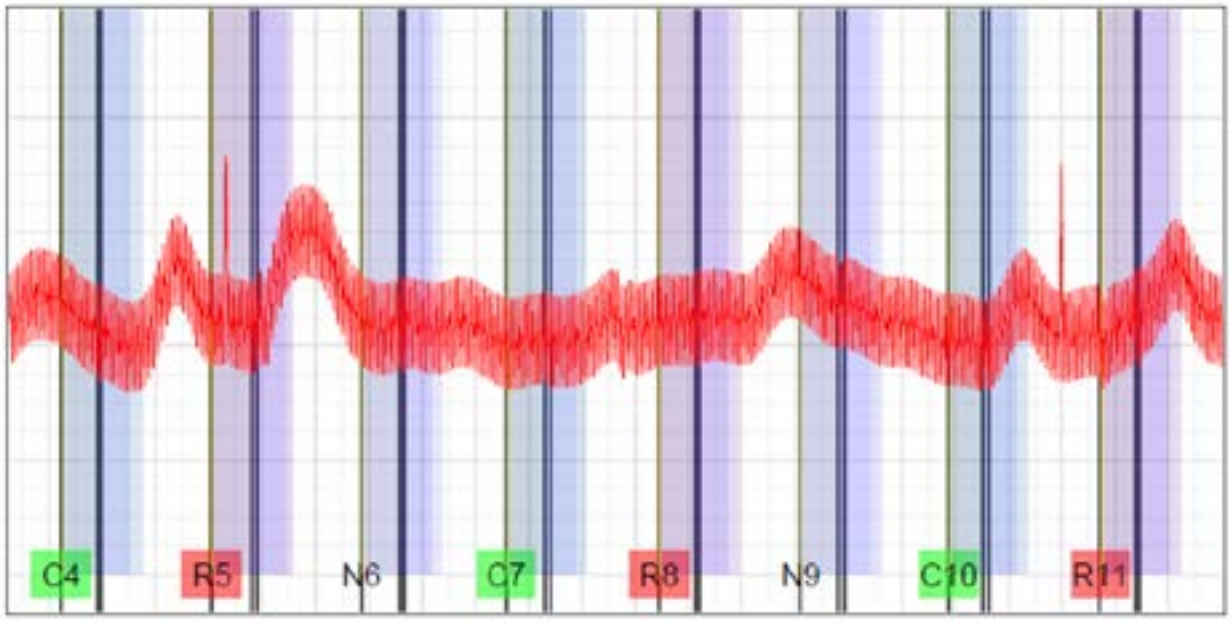
Figure 3. Cardio-arrhythmia.



Fasciculations (involuntary muscle twitches)

Muscle fasciculations, shown in Figure 4, are, by definition, involuntary. In the polygraph context these are observed as a single cardiac pulse cycle that displays an uncharacteristic elevation, relative to the in the systolic line, followed by an immediate return to the normal observed pattern of activity. These movements do not disrupt the activity of the diastolic baseline or systolic peak line.

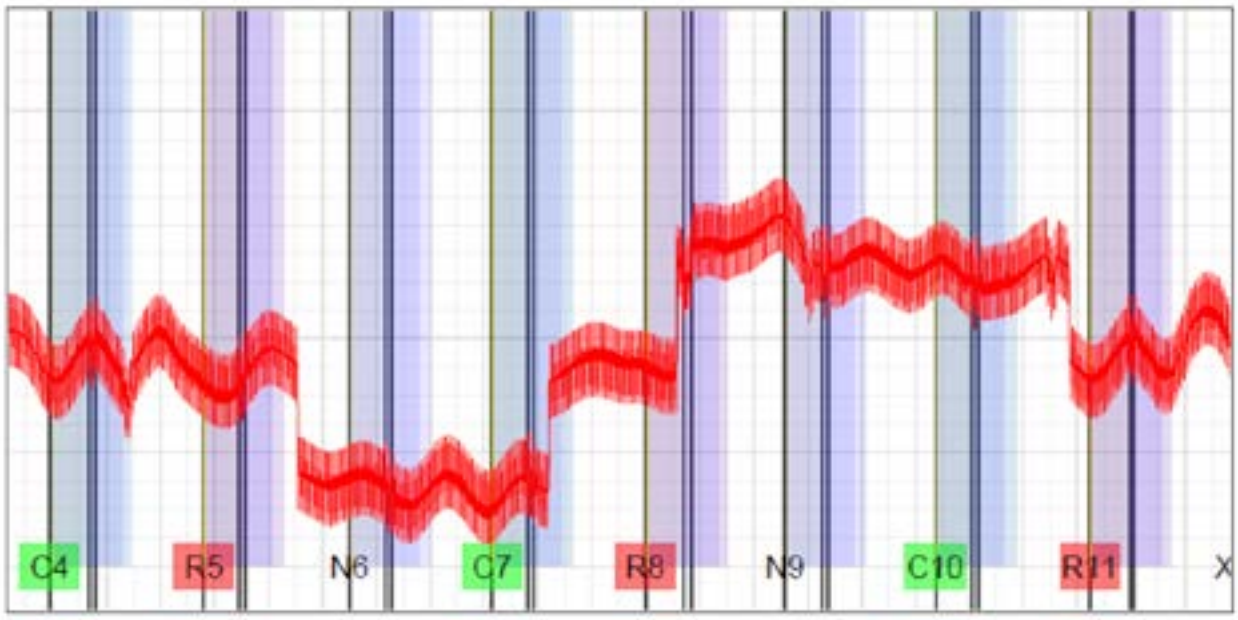
Figure 4. Fasciculations in cardiovascular data.



Physical movement

Physical movement artifacts, shown in Figure 5. are the result changes in physical position. These artifacts are uncharacteristic of responses to test stimuli and are observed as rapid changes that occur within the space of one or two cardiac pulse cycles. They are distinct from involuntary movements in that they characteristically introduce a distinct or dramatic change to either the diastolic baseline, systolic peak line, or both. Physical movements can be reproduced voluntarily. It is also within the realm of possibility that these may occur, at times, due to involuntary activity. Polygraph field examiners can make use of statistical methods to calculate the statistical likelihood that observed physical movement is random or systematic.

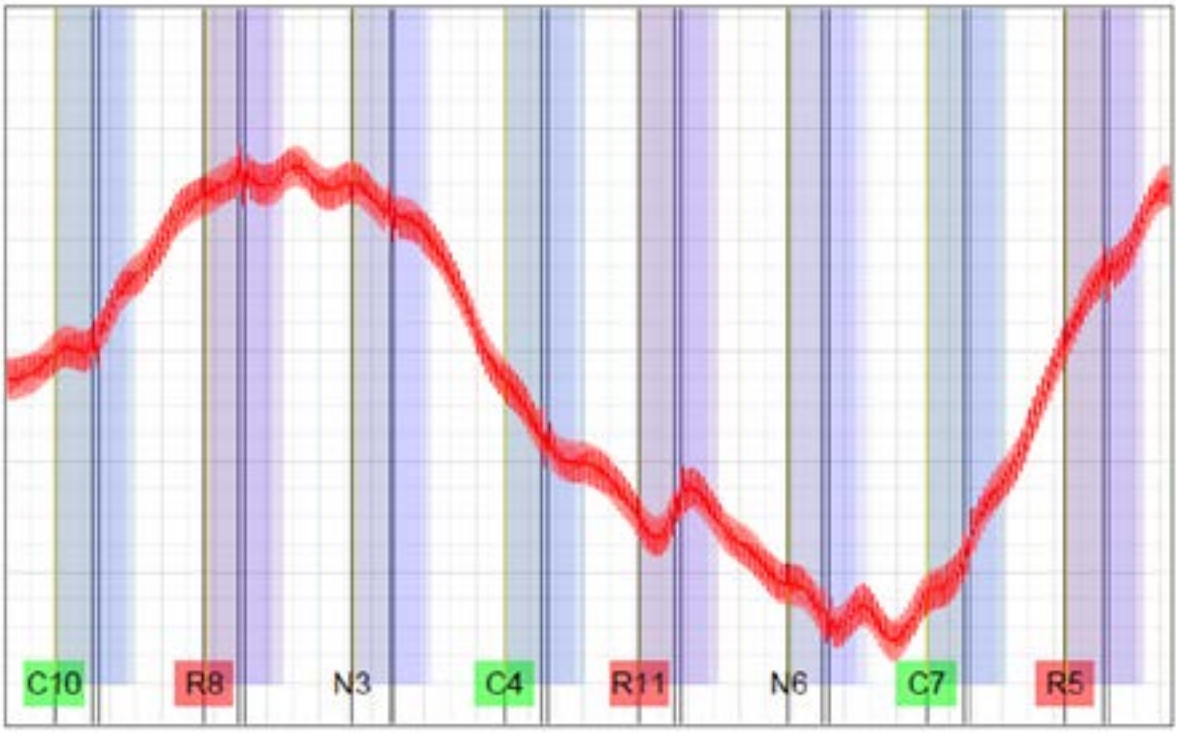
Figure 5. Physical movement observable in cardiovascular data.



General instability

General instability, shown in Figure 6, is observed as a pattern of substantial variation in cardio data, not attributable to a sensor malfunction or other identifiable condition. This activity is independent of the sequence and presentation of the polygraph test stimuli. General instability is distinct from normal phasic responses, and distinct from the more rapid changes that are characteristic of other cardio data artifacts. General instability cannot be easily reproduced voluntarily and has been anecdotally related to blood sugar levels for some persons.

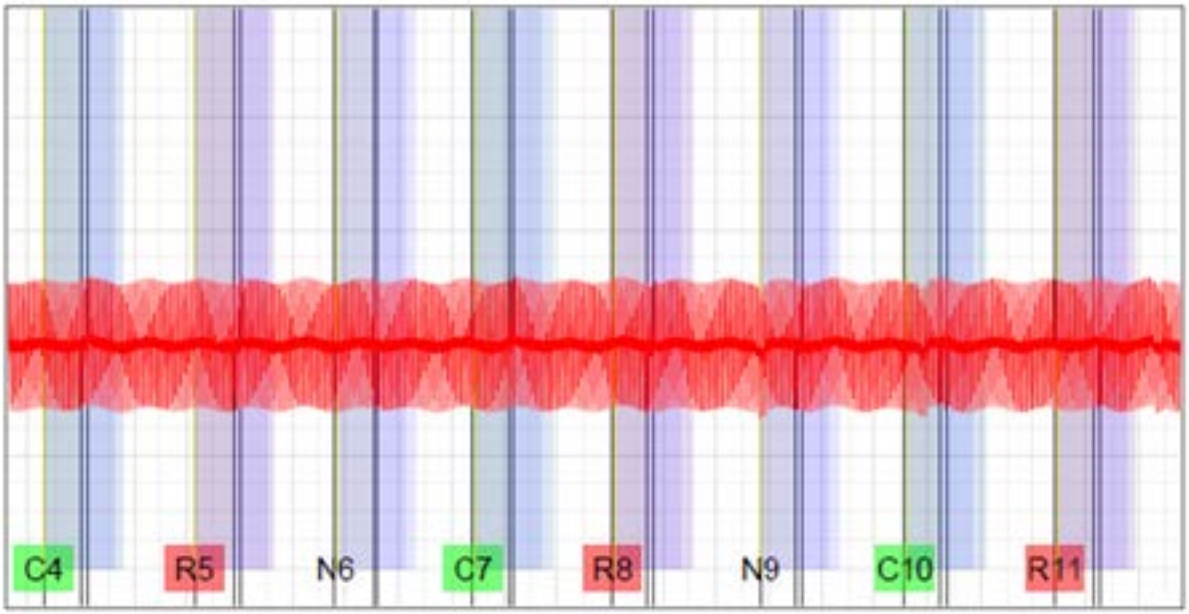
Figure 6. General instability.



Dampened or unresponsive cardio data

Figure 7 shows as example of cardiovascular data of dampened or unresponsive quality. This can be the result of a variety of possible causes, including possible underlying health conditions, certain medications, or combinations of medications, and physical fatigue.

Figure 7. Dampened or unresponsive cardiovascular data.



Conclusion

This project is an illustration of commonly observed data artifacts in cardiovascular signals recorded during polygraph testing. It is intended to promote reasonable understanding and coherent discussion about data artifacts, including possible causes and effects. Some types of cardio data artifacts will have global effects that are indiscriminate of the individual test stimuli. Other cardio artifacts cannot be reproduced voluntarily. And finally, some cardio data artifacts may be induced through either voluntary or involuntary causes. Data artifacts of unknown cause may represent an area of interest around the potential that they may occur secondary to covert efforts to disrupt or alter the test result.

An ideal countermeasure strategy would involve conscious or voluntary control over one's autonomic responses while producing data that are indistinguishable from authentic autonomic data. Although there is intense speculation as to this possibility, the premise of an ideal strategy of this type is inconsistent with the fact that autonomic activity of interest to the polygraph test is generally regarded as outside the domain of conscious control. Voluntary or somatic activity is likely to alter the cardio data in ways that are inconsistent with normal autonomic activity. This represents both a risk and a dilemma to those who attempt to engage in voluntary activity during polygraph testing. Systematic activity may be observed or detected, while non-random or pseudo-random activity will increase the likelihood that the activity will fail to alter the loading of physiological activity in the intended way.

Artifacts that cannot be produced voluntarily are substantially less amenable to becoming strategically exploited and can be regarded as inconvenient noise in the data. As a practical matter, it is not necessary that the exact cause of any artifact is known. Quite often it is impossible to know the exact cause of unexpected activity. This is partially because it is impossible to read the mind of the examinee. It is often sufficient to know only whether an observed artifact can be produced voluntarily.

Involuntary artifacts – those that cannot be reproduced voluntarily – can simply be excluded from the analysis. In contrast, artifacts that can be reproduced voluntarily cannot be immediately and easily ruled out as mere inconvenience. Instead, artifacts of unknown cause can be subject to ancillary analysis to determine the possibility or likelihood that they conform to a systematic distribution or pattern. All polygraph professionals should strive to become familiar with data of normal interpretable quality, in addition to various types of data artifacts and their possible causes. The types of cardiovascular data artifact illustrated herein are an introduction to some of the common artifact signature patterns that skilled examiners will easily recognize.