Abstract

The way individuals respond to emotional episodes may be influenced by their dispositional motivational tendencies. Of special interest are those interactions between emotion and motivational attributes that affect cardiovascular activity and may thereby contribute to the onset and development of cardiovascular disease. To determine the links between emotions, motivational attributes, and cardiovascular health, we recently conducted a study in which participants were asked to recall two events: one that made them feel angry and one that made them sad. Measures of blood pressure and heart rate were obtained while participants recalled and described these emotional events. Participants also completed questionnaires measuring motivational tendencies toward behavioral activation and behavioral inhibition. In this article, we discuss important methodical considerations that arose as we developed this study, including design choices that are relevant to many kinds of research questions (e.g., using continuous predictor variables and a within-subjects experimental design) and choices that were more specific to our particular research questions (e.g., how to induce emotions and assess cardiovascular responses to emotional provocation). The resulting methodological discussion therefore may help inform future research, particularly that utilizing individual difference predictors, experimental emotion inductions, and cardiovascular dependent measures.

Learning Outcomes

By the end of this case, students should be able to

- Note the strengths and weaknesses of using student samples in cardiovascular research
- Recognize the flaws of dichotomizing continuous variables
- Determine when a within-subjects design is appropriate for different research questions
- Identify the best way to induce specific stress emotions for the topic under study
- Understand best practices for measuring cardiovascular activity

In a series of studies, we sought to develop and evaluate laboratory methods for testing hypotheses concerning personality attributes, emotion, and measures of cardiovascular activity that have been implicated in the development of heart disease (Bajaj et al., 2017; Betensky & Contrada, 2010; Weisberg, Bajaj, & Contrada, 2016). In discussing the research methodology we employed, we will focus mainly on a study in which we examined cardiovascular reactivity to anger and sadness as a function of personality differences in behavioral activation and behavioral inhibition (Weisberg et al., 2016). Some of the considerations and choices that went into the design of this study are specific to the particular research questions and hypotheses we addressed. Others are more generic and, therefore, relevant to a wider range of research projects.
Project Overview and Context

The general premise of this research was that personal attributes, including enduring emotional conditions, such as major depressive disorder, and personality characteristics, such as trait aggressiveness, interact with the situational elicitation of stress emotions. That is, negative emotional states, such as anger, sadness, and anxiety, are expected to be more pronounced in individuals who are psychologically predisposed due to psychopathology or personality. Of particular interest are those individuals who show pronounced cardiovascular responses during these emotional episodes, as this form of physiologic reactivity appears to contribute to the development of coronary heart disease. Although there is considerable support for this idea, questions remain about precisely which personal attributes and what forms of stress and stress emotions are most influential. In Weisberg et al. (2016), we chose to induce states of anger and sadness as a means of provoking cardiovascular activity. This was based on epidemiological evidence linking anger- and depression-related states and conditions to the development of coronary heart disease (Bekkouche, Holmes, Whittaker, & Krantz, 2011).

The personality attributes we examined were the motivational dispositions measured by the behavioral activation scale (BAS) and behavioral inhibition scale (BIS) of Carver and White (1994). Behavioral activation involves energization and engagement in the process of goal pursuit, whereas behavioral inhibition involves avoidance of aversive stimuli. The BAS and BIS were chosen based on the notion that these behavioral tendencies may constitute basic motivational systems that underlie stress emotions and their impact on health-damaging physiological processes. Specifically, as anger arises when goals are impeded, but still attainable, angered people are likely motivated to continue engaging in goal pursuit and this should be reflected in greater cardiovascular activity. Alternatively, as sadness occurs when a goal has been thwarted and now appears impossible to attain, sad people are likely to disengage from goal pursuit and this should be reflected in lower cardiovascular activity.

To illustrate, imagine a woman overhears a remark from her male boss implying that women are less suited for managerial roles compared with men. If the woman feels she can effectively counter her boss’ behavior, she will likely feel angry and engage in actions such as reporting her boss to human resources to challenge the inappropriate remark. She may even confront him directly. If, on the contrary, the woman in this scenario feels she cannot confront her boss’ sexist remark without negative repercussions (e.g., getting fired), she will likely experience sadness and show little motivation to address her boss’ condescending statement. How angry or sad the woman feels, and how much cardiovascular activation she shows, should depend on her characteristic behavioral activation and behavioral inhibition tendencies because these personality attributes are temporally stable and hypothesized to influence motivational intensity in a range of situations.

In our study, cardiovascular activity was monitored through noninvasive measures of systolic and diastolic blood pressure (SBP and DBP) and heart rate (HR). These physiological indices were chosen because of their links to future cardiac health (Bekkouche et al., 2011). Consistent with hypotheses, we found that BAS
was positively associated with SBP and DBP elevations in an experimental condition designed to make participants feel angry and was negatively associated with SBP and DBP elevations when participants were made to feel sad. However, behavioral inhibition was not associated with any measure of cardiovascular activity.

Research Practicalities

Participant Recruitment

Practical constraints necessitated that research participants be drawn from an undergraduate general psychology subject pool. Although this limits the generalizability of the findings to other populations, it also comes with some advantages. The subject pool is relatively homogeneous with respect to age. This limits variability in dependent measures, potentially increasing statistical power, because age can influence cardiovascular reactivity. A similar situation would arise in a study that was interested in reading comprehension as a dependent variable. The variability in reading comprehension ability would be large in a sample including high school, college, and doctoral students. High school students would score at the lower end of the scale, whereas doctoral students would tend to score near the top. In both cases, a more heterogeneous sample would show more variability in the dependent variable (cardiovascular reactivity; reading comprehension) due to factors not related to the purpose of the study (age, education level). This makes it harder to show a statistically significant effect for the predictor of interest (e.g., motivational dispositions) without recruiting a larger sample or complicating the statistical analysis by including age or education level as additional predictors (Keppel & Wickens, 2004). The wider range of scores (i.e., greater variability) reduces statistical power by comparison with a narrower range of scores.

In addition, the level of education guarantees participant literacy and an ability to comprehend and accurately carry out the study instructions. Moreover, undergraduates are relatively healthy, from both a physical and mental health standpoint, allowing researchers to capture disease-promoting factors that may be involved in the initiation or very early developmental stages of coronary heart disease. Furthermore, the health of this population allows study without the interfering effects of major health problems and medications. Cardiovascular disorders can alter SBP, DBP, and HR, as can many medications prescribed in later life (e.g., antihypertensives and antiarrhythmic agents). Using a young and generally healthy sample obviated the need to control for these potential influences. Notwithstanding these advantages, follow-up research would do well to recruit older, less healthy, and more diverse participants. Recruiting a study population different from the undergraduate subject pool will allow greater generalization of the study results.

A last note concerning participants in studies using physiological measures, it is imperative to ask participants to refrain from caffeine, nicotine, alcohol, other drugs, and from physical exercise, for at least 2 hr prior to the study session, because these activities are known to influence cardiovascular activity (Edenfield & Blumenthal, 2011; Grunberg, Berger, & Hamilton, 2011). Participants typically are willing and able to disclose
information concerning their intake of substances or engagement in activities that may interfere with accurate cardiovascular readings prior to study participation.

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**Research Design: General Considerations**

Two aspects of the design we have employed in this research represent generic options for the study of a wide range of phenomena. One was the integration of a correlational design involving the use of continuous, individual difference measures with an experimental design involving the manipulation of conditions for producing different psychological states. The second pertains to the type of experimental manipulation, which was done on a within-subjects rather than a between-subjects basis. As discussed below, both of these features of the study design involved a consideration of the costs and benefits of alternative approaches. These decisions were partially a matter of preference and depended mainly on their suitability for serving the goals of the research.

**Continuous Predictors**

The nature of the research question dictated the use of a correlational/individual difference design. Personality was a focus of the research, and personality cannot readily be manipulated experimentally because it is relatively stable and more complex than the kinds of psychological factors that are modifiable, for example, by weeks of psychotherapy. A single experimental session is rarely sufficient to instill change in modifiable psychological factors, and much less so with more stable personality factors. We might have attempted to induce temporary psychological states that resemble the dispositions of interest. For example, a moderately difficult task, compared with one that is very easy or apparently impossible, can create what is arguably a state of behavioral activation (Wright & Barreto, 2012). Similarly, threatened delivery of aversive physical stimuli (e.g., electric shock) could produce what might be regarded as a state of behavioral inhibition. But this approach would lead to a rather complex experimental design (i.e., adding two experimental manipulations to the manipulation of anger versus sadness would yield a three-way factorial). Moreover, this would have left us with the empirical question of whether those temporary states of behavioral activation and behavioral inhibition actually represented the personality dispositions of interest. We did not give serious consideration to this alternative, although other research with different goals has made effective use of such an approach (e.g., Wright & Barreto, 2012).

Once we decided to focus on naturally occurring individual differences, there was little question that we would use continuous measures of the relevant constructs. Constructs referring to dispositional tendencies to experience behavioral activation or inhibition are continuous by definition. To represent them as such necessitated a research design incorporating main effects and interactions involving continuous measures of personality along with effects of the experimental manipulation. This type of mixed design is clearly favored by many experts (e.g., Aiken & West, 1991) over designs in which the continuous predictor is forced into a categorical operationalization (e.g., by partitioning the sample using a median split of the personality...
measure). Although dichotomized variables may be in some ways easier to compute and explain, and yield data that are easier to analyze, meaningful variability in the data is lost and the effects of incremental differences in the attribute of interest are obscured. Therefore, using dichotomized variables is faulted on a statistical basis for reducing precision and potentially compromising statistical power (Cohen, Cohen, West, & Aiken, 2003). Furthermore, the dichotomization approach is limited at a conceptual level by its departure from the continuous nature of the underlying construct.

**Within-Subjects Design**

The experimental component of the design involved a manipulation constructed to induce either a state of anger or a state of sadness. The choice of a within- as opposed to a between-subjects manipulation to achieve this goal was less clear-cut than using continuous versus categorical predictors. Each of these design alternatives, in theory, comes with a set of well-known strengths and weaknesses.

One potential advantage of a within-subjects approach, which we weighed heavily, was the potential for greater statistical power (Charness, Gneezy, & Kuhn, 2012). As it is commonly expressed, in a within-subjects design, each participant is his or her own control. This reflects the fact that stable, pre-manipulation variation in person factors within each experimental condition that might influence the dependent measures is minimized in a within-subjects design. Because the same participants are involved, they are at identical levels in each treatment condition. By contrast, in a between-subjects design, even with flawlessly executed random assignment to conditions, participants in two different experimental conditions may differ in terms of pre-existing characteristics that influence the dependent measures and consequently can bias the results (Charness et al., 2012). This is because random assignment only works to create equivalent experimental groups on average, over many replications. Moreover, even if there are no such pre-treatment differences, within-subjects designs typically have less within-condition variability, reducing error terms and increasing statistical power. The potential to minimize these sources of bias and variability was attractive to us in large part because the effects of global personality constructs such as behavioral activation and inhibition are not expected to be all that powerfully manifested in any single situation; instead, they are expected to predict consistency in response to a range of conceptually congruent situations. This nudged us closer to the use of a within-subjects design, with which we thought we would be able to detect the phenomena of interest using fewer participants.

The case for a within-subjects design was further strengthened by the fact that it would make available a measure at the level of individual participants of the differential effects of experimental conditions (Keppel & Wickens, 2004). Thus, we are able to compute a score for each participant that measures the difference between his or her response to a state of anger versus a state of sadness on each of our dependent measures. This is not possible in a between-subjects design. It confers a significant advantage given the nature of our research question.

Our choice of the within-subjects experimental component was not without its disadvantages. Many of these
concern the lack of independence of the effects of the two experimental conditions with respect to each other or in relation to the passage of time. For example, the effects of whichever psychological state is induced first (e.g., anger) may influence those of the second (e.g., sadness). Other issues do not involve the experimental conditions per se, but other, time-dependent phenomena. During the course of the experimental session, factors such as adaptation to the laboratory setting, fatigue, and impatience may accumulate and confound experimental conditions that are induced at different points in time. For example, imagine you are taking a long comprehensive exam. During the first 30 min, you can easily stay focused, read passages, and answer questions without hesitation. However, after 1.5 hr, you move on from the verbal section to the quantitative portion of the exam. Now you are mentally exhausted, becoming hungry, and can no longer focus on the questions. All things equal, your scores in the verbal section you took first are likely to be higher than your scores on the quantitative section you took later, because of the overexertion of your executive control. Likewise, participants in experiments may become overexerted and respond differently to manipulations at the end of a study than they would have if they were exposed to that same manipulation at the beginning of the study.

Some of these factors can be addressed through counterbalancing. In a simple design such as ours, this was a matter of randomly assigning half the participants to undergo the anger induction first, with the remaining half undergoing the sadness induction first. In more complex designs, for example, with multiple within-subjects manipulations involving more than two experimental conditions each, correspondingly more complex counterbalancing schemes are available. It is important to note that counterbalancing does not eliminate variance due to order in which experimental conditions are induced, or to the passage of time, but it does cause it to be averaged out across experimental conditions and can minimize the opportunity for confounding.

With respect to the issue of statistical nonindependence of observations made under different experimental conditions in a within-subjects design, there are at least two options. The classic, repeated-measures ANOVA approach to statistical analysis relaxes the independence assumption of between-subjects ANOVA. There emerges a different, and rather important, statistical assumption having to do with the pattern of correlations of dependent measures across experimental conditions. However, this assumption does not apply to designs such as ours involving a single, two-level within-subjects factor. An alternative appropriate for larger designs that permit statistical dependence across levels of a within-subjects design is a MANOVA. However, when statistical assumptions are met, repeated-measures ANOVA is more statistically powerful than MANOVA, thereby justifying its use in those cases.

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**Research Design: Topic-Specific Considerations**

We now turn to methodological considerations that are more specific to our research, but may be beneficial for others conducting similar studies.

**Inducing Emotion**
Another methodological choice we made concerns the procedures used to induce states of anger and sadness at a level of intensity sufficient to influence cardiovascular reactivity. These physiological changes describe what is known as the “Fight-or-Flight” response and can be elicited by psychological threats. In our research, its activation demonstrates that a threat-related, negative emotional state has been elicited. The magnitude of the response also supports the hypothesis that the observed changes have implications for the development of cardiovascular disease.

There are many methods for inducing negative emotions in the laboratory. At one extreme are manipulations in which a “real” threat is staged within the laboratory. For example, the experimenter or a confederate may insult, criticize, or harass the participants, as a means of inducing anger (e.g., Glass et al., 1980). Manipulations such as these may have a considerable amount of experimental realism and produce intense emotional responses. However, they can be difficult to stage, even more difficult to standardize across participants, and may have complex effects; for example, multiple different emotional states may be induced across participants or even within a single participant. Moreover, whereas anger can be induced using insults or other forms of unfair treatment that are plausible within the experimental setting, sadness usually arises as a result of personally meaningful psychological losses that are not easily represented in the laboratory, such as in bereavement, academic failure, or losing one’s job.

As an alternative to staging a “real” emotion-inducing threat in the laboratory, we elected to use an autobiographical recall task. We had participants recall an actual, recent event that caused them to feel angry, and one that caused them to feel sad, in two separate phases of the experimental session, the order of which, as previously noted, was counterbalanced across participants. Their instructions were to first think about the event and then to describe it aloud. This task has several key features.

First, there was no staging of events in the lab to produce emotional reactions. The experimenters were trained to project knowledge and authority, with some sensitivity to the possible discomfort associated with physiologic recording instruments. However, they did nothing to provoke anger, sadness, or other negative emotions. If participants followed instructions, any emotional reactions were produced by recollection of actual events in their past—not from the experimenter.

Moreover, this type of task depends in part on participants’ ability to recall stressful events in a vivid manner. To facilitate this, participants were guided by instructions to re-experience thoughts, feelings, and sensations that occurred during the event, to recreate mentally what happened at the time, and to prepare to describe it aloud when so instructed. The focus on sensory and motor cues has been shown in previous research to help to create vivid emotional imagery along with physiological activity (Lang & Bradley, 2010). When asked to describe the event aloud, participants spoke about the incident for 3 min. If a participant stopped speaking before 3 min elapsed, the experimenter encouraged the participant to continue speaking. Furthermore, any participant that continued to talk after 3 min was asked to stop. These procedures ensured that all participants engaged with the task for the same amount of time. Speaking amplifies affect and its physiological concomitants and therefore was also important to this study (Lynch, Long, Thomas, Malinow, & Katcher, 1981; Siegman, 1993).
Having participants speak about a real emotional event in their recent past distinguishes the task we used from other speaking tasks that have been employed to provoke stress or emotion. Some speech tasks are designed to maximize evaluative concern by requiring participants to act as though they are convincing managers to hire them to fill a position while receiving negative feedback on their efforts (e.g., Trier Social Stress Test; Kirschbaum, Pirke, & Hellhammer, 1993). Others aim to activate reactions to imagined unfair treatment, as when African American participants are all presented the same recording of a racist event and asked to describe how they would react to such a situation (Merritt, Bennett, Williams, Edwards, & Sollers, 2006). These situations differ from the autobiographical recall task that we used in that the stimuli and instructions structure the content of participants’ thoughts and verbalizations. They may well activate memories of real events, but then again, they may not; imagined events can be stressful and thereby satisfy the researcher's purposes (e.g., Merritt et al., 2006), but we did not think such an approach would suit ours.

One rationale for using an autobiographical recall task was that we thought it an effective way to activate relatively pure states of anger and sadness. Had we given a single standardized description of an anger- and sadness-inducing situation for participants to discuss, it might have introduced variable emotional reactions associated with individual differences across participants in perceptions of those situations and their personal relevance. We expected that instructions to recall events associated with anger or sadness would allow each participant to select an appropriate event, and that personal significance and meaningfulness would work in our favor by producing intense feelings and strong physiologic responses. These expectations were borne out by the data for affect ratings obtained following each experimental condition, and by the findings indicating different associations between BAS scores and cardiovascular reactivity to anger versus sadness.

Despite having some basis for taking this approach, including our analysis of task demands and previous research findings, it is not without its drawbacks. Recalling an emotional event in a laboratory setting will not generally produce emotions of the same intensity as those elicited when ongoing, as opposed to recalled, events provoke anger or sadness. There is some experimental realism inherent in speaking about upsetting events of the past, but aspects of the laboratory setting and the nature of the experimenter–participant relationship act as limiting factors. In addition, the actual or presumed scrutiny to which participants are subjected in any laboratory setting provokes evaluation apprehension. Unlike some speaking tasks, in which social evaluative concerns, even stage fright, are the intended consequences, our desire to provoke memory-based anger and sadness could be undermined by this feature of the experimental setting. Despite training experimenters to appear neutral and instructing the experimenter to leave the room before the participant began the speaking tasks, participants still might have felt apprehensive about evaluation simply by the presence of another individual within earshot.

**Psychophysiological Methodology**

Another consideration specific to this research involves the physiological focus of our study. There are many physiological measures that we could have utilized, including other cardiovascular indices derived from impedance cardiography (IC) or beat-to-beat heart rate variability (HRV). These methods may have
given a more in-depth look into the physiological reactions associated with anger and sadness. For example, indices from IC are thought to reveal whether sympathetic activation primarily affected the activity of the heart, causing it to beat with greater force, or of the blood vessels, causing them to constrict, whereas HRV is believed to give an estimate of parasympathetic influences on the cardiovascular system. The different cardiovascular patterns detected by IC and the parasympathetic activation reflected in HRV have important implications for cardiovascular health. However, such indices are not without their drawbacks. For instance, more set up time is required for IC and HRV compared with BP and HR due, for example, to the number of electrodes required. Furthermore, procedures for editing and analyzing IC and HRV data are more time-consuming and require more investment in researcher training.

Our decision to use BP and HR reflected more than time considerations. Blood pressure and HR have consistently been used in the literature, making our study amiable to potential future literature reviews and meta-analyses (Chida & Hamer, 2008). Furthermore, BP and HR have been consistently linked to future cardiac functioning (Bekkouche et al., 2011). The broader goals of our research were to ascertain how emotional states, personal attributes, and physiological responses may play a part in the development and progression of cardiovascular disease. With cardiovascular disease ranking as the number 1 cause of death for women and men in many countries (World Health Organization, 2017), we thought it is important to maintain contact with the literature concerning the ways emotions and personality factors may contribute to this significant public health problem.

After deciding to use BP and HR as our physiologically dependent measures, other procedural considerations needed to be addressed. First, to measure cardiovascular reactivity, baseline measures of cardiovascular activity need be collected. Procedures for establishing cardiovascular baselines typically require participants to sit still with their legs uncrossed for at least several minutes while they acclimate to the environment. Often times being in a laboratory setting and fashioning physiological equipment can be intimidating for participants. Therefore, it is vital that participants relax after being fitted with physiological equipment for a time before the study tasks or manipulations are introduced. The length of the baseline period can vary considerably from experiment to experiment. We chose 8 min based on similar studies from our lab and others showing that a reliable baseline can be derived over that time course. Furthermore, the longer the baseline interval, the greater likelihood that participants fidget or fall asleep which interferes with obtaining an accurate cardiovascular reading.

Task duration also needs to span the course of a few minutes to provide accurate and reliable measures. Three minutes for each of our emotion inductions was reasonable for collecting accurate readings and keeping participants actively engaged with little fatigue. Furthermore, because we used a within-subjects design, requiring participants to recall an anger and sadness event, an 8-min rest period was interposed between emotion inductions. Without a rest period between tasks, physiological readings from the first manipulation are likely to interfere with those during the second task, making it difficult to determine the unbiased influence of the independent variables.
Conclusion

Several general and specific methodological considerations arose in designing our study. We reviewed the advantages and disadvantages of using a student sample, continuous predictors rather than dichotomized variables, a within-subjects compared with a between-subjects design, an autobiographical recall task versus other emotion inductions, and HR and BP as physiological measures. When designing any experimental study, many choices require consideration. Often there are tradeoffs for choosing one methodology over another. The researcher question should be the guiding force driving these decisions. Researchers should consider how to best answer their research question without impinging upon statistical power, generalizability, or scientific integrity. The ultimate goal of this piece is to encourage and assist others studying related topics, especially those addressing cardiovascular health, to make informed methodical considerations and decisions, and thereby expand our current knowledge of such topics.

Exercises and Discussion Questions

1. What advantages and disadvantages does recruiting a student sample for physiological research yield?
2. Why should continuous variables not be dichotomized?
3. What is one advantage of a within-subjects design?
4. If you were to conduct a follow-up study to replicate and expand the results of the experiment in this case, how might you induce emotion?
5. When collecting cardiovascular data, such as blood pressure and heart rate, in a laboratory, why is a baseline measurement of cardiovascular activity important?

Further Reading


References


