PRE-DONATION FLUID LOADING ATTENUATES NEGATIVE REACTIONS IN FIRST-TIME BLOOD DONORS

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This thesis entitled

PRE-DONATION FLUID LOADING ATTENUATES NEGATIVE REACTIONS IN
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BY

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Novice blood donors are at an increased risk for such symptoms as dizziness and lightheadedness. Adverse reactions occur in response to decreases in blood pressure and the resultant inadequate cerebral perfusion. Laboratory studies have demonstrated that water ingestion can produce an acute increase in resting blood pressure. To test this, 83 first-time blood donors (48% female) were randomly assigned to either a pre-donation water or no water condition. Donors in the water condition consumed 500 ml of bottled water approximately 30 minutes before donating. Following donation, all participants completed the Blood Donation Reactions Inventory (BDRI), which is a measure of subjective physiological reactions such as faintness and dizziness. Results of a 2 Group (water, no water) x 2 Sex (male, female) ANOVA of BDRI scores revealed a main effect of Group, $F(1, 79) = 11.81, p = .001$, reflecting significantly lower BDRI scores in those who consumed water prior to donation.

Approved: Christopher R. France

Professor of Psychology
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INTRODUCTION

Negative responses to blood donation are a major obstacle to retention of existing donors. Approximately 28% of blood donors experience some sort of negative reaction to donation (e.g. dizziness, nausea). The psychological impact of experiencing adverse reactions usually results in negative attitudes about donation and consequently decreased intentions by donors to return. For that reason, interventions designed to reduce the adverse effects of blood donation are important and likely to increase donor retention. In the present study, pre-donation fluid loading was explored as a strategy for lowering the risk for subjective physiological reactions to blood donation in first-time donors.

In the following section, I will review information on current trends in donor behavior and aspects of the typical blood donor. This will be followed by a discussion of a major deterrent of repeat blood donation—negative donation reactions. I will also discuss influential demographic, physiological, and psychological factors that precipitate these reactions, in addition to how they have been prevented in the past. Lastly, fluid loading and its physiological effects will be explored.

Trends in Blood Donation in the United States

The aging of the population in the United States and the fact that only about 5% of Americans donate blood each year raise concerns about the assurance of an adequate, safe supply of blood in the future (Gillespie & Hillyer, 2002). Over the past few decades, the United States has been experiencing an increasing demand for blood. The onset of the AIDS epidemic of the 1980’s contributed to a decline in collection rates (McCullough, 1993; Piliavin, 1990). Specifically, an estimated loss of one-half million...
donors per year was attributed to enhanced screening for transfusion-transmitted
diseases. High-risk behavior, such as intravenous drug use and unprotected sex, has also
been used to screen out potential donors.

The decline in collection rates may also be due to mandatory or voluntary
limitations on donors related to the emergence of infectious agents such as babesia,
prions, and trypanosomes (Gillespie & Hillyer, 2002). As of September 2001,
Creutzfeldt-Jacob disease has been established as a danger, causing an added donation
restriction and an estimated donor loss of 7-11% (Gillespie & Hillyer). Overall, when
accounting for medical deferral factors, only 67% of men and 55% of women in United
States are eligible to donate (Ferguson, 1996).

As a whole, blood donation rates have been declining and transfusion rates have
and 1997, blood collection rates of whole blood units dropped six percent (National
Blood Data Research Center, 2003). Although more blood is collected than transfused,
the gap between the supply of donated blood and the demand for blood for transfusion
has narrowed substantially (National Blood Data Research Center). In addition, these
numbers do not reflect shortages of donated blood in terms of specific blood types,
regional demands, and seasonal fluctuations. Figure 1 illustrates this narrowing gap
between blood collected and transfused since 1987.

Many donation sites have reported declines in first-time donors despite significant
growth in program funding for recruiting such donors (Whyte, 1999). Some areas of the
Figure 1

United States are seeing close to a 7% reduction of first-time donors (Wu et al., 2001). The general conclusion is that currently, the vast majority of donors are a core group of committed repeat donors. In fact, over time, repeat donors have consistently represented 78% to 91% of all donors (London & Hemphill, 1965; Piliavin, 1990).

Researchers have hypothesized that the only logical way to increase the blood supply is to utilize existing donors and to increase the amount of blood donated by this small but loyal group of people (Callero & Piliavin, 1983; Malloy, McDonough, & Fuller, 1991; Miller & Weikel, 1974; Piliavin & Callero, 1991; Wallace & Pegels, 1974). Their rationale is that since enough returning donors preside in any area of the world to produce six to ten times the amount of blood needed (Wallace & Pegels), retention of existing donors should be more efficient than recruitment efforts targeting first-time donors (Miller & Weikel). All in all, this does not impart that recruiters should stop targeting first-time donors. In fact, our primary goal should be to get more new donors into the system and to retain them. If we are to avert a future shortage, we must get better at retaining first-time donors.

**Definition of Blood Donation Reactions**

The reality that many donors do not return can be blamed on many things, including motivation, lack of interest, lack of time, and the experience of negative physiological reactions due to blood donation. Past research has focused mainly on negative reactions. The psychological impact of experiencing adverse reactions usually results in negative attitudes about donation and consequently decreased intentions by donors to return (Piliavin, 1990).
Ratings of negative reactions can differ between blood collection agencies. Typically, the phlebotomist will rate donation reactions and not the donor. However, rating scales may vary significantly, with some agencies rating a full faint as a severe reaction and some rating it as a light reaction. Due to this inconsistency between agency ratings, data on rates of blood donation reactions is complex and weak. Currently, the American Red Cross classifies all donations according to one of four categories:

1. **No reactions.** The donor has experienced no reactions to blood donation when the donor endures no physiological changes as a result of donation.

2. **Light reactions.** Light reactions are the most common level of blood donation reactions. Reactions in this category include one or more of the following reactions: lightheadedness, sighing, yawning, hyperventilation, cold or clammy perspiration, feeling warm or chilled, restlessness, tingling or numbness in the face or extremities, pallor and sweating, mild nausea, dizziness, a small or brief drop in blood pressure, a small or brief drop in heart rate, or loss of consciousness for less than one minute.

3. **Moderate reactions.** Donors who experience one or more light reactions in addition to one or more of the following reactions are categorized as having moderate reactions. Moderate reactions include vomiting or severe nausea, a large or sustained drop in heart rate, loss of bladder or bowel control, or loss of consciousness for more than one minute.

4. **Severe reactions.** Severe reactions include one or more of the light and/or moderate reactions, in addition to one or more of the following: a large or
sudden drop in blood pressure, chest pain, convulsions, rigidity, tremors, or cyanosis.

Up to 28% of blood donors experience some sort of mild to severe negative reaction to donation (Callahan, Edelman, Smith, & Smith, 1963; Graham, Kabler, & Lunsford, 1961; Kaloupek, Scott, & Khatami, 1985; McVay et al., 1990; Ogata, Iinuma, Nagashima, & Akabane, 1980; Piliavin & Callero, 1991; Trouern-Trend, Cable, Badon, Newman, & Popovsky, 1999; Wright, 1989). Fainting and more severe reactions are rare, whereas mild reactions are not. Approximately one percent of all donors lose consciousness while donating blood (Trouern-Trend et al.).

In response to the inconsistency between agency ratings of negative reactions, it may be beneficial to construct one universal blood donation reactions rating scale. Since losing consciousness is uncommon, the reaction categories constructed by the American Red Cross, in which loss of consciousness can be considered a light reaction, seem inaccurate. Based on the literature (Kasprisin, Glynn, Taylor, & Miller, 1992; Trouern-Trend et al., 1999), donation reactions would be more accurately rated by a scale similar to the following: (1) “no reactions”—no physiological changes as a result of donation, (2) “mild reactions”—lightheadedness, cold or clammy perspiration, feeling warm or chilled, restlessness, tingling or numbness in the face or extremities, pallor and sweating, or dizziness, (3) “moderate reactions”—hyperventilation, nausea, or vomiting, and (4) “severe reactions”—fainting with or without convulsions. Negative reactions occur due to a complex combination of physical and psychological factors. The following section
will review the known psychophysiological contributors to negative reactions during blood donation.

**Psychophysiological Contributors to Blood Donation Reactions**

What are the cardiovascular mechanisms that lead blood donors to experience reactions? Vasovagal syncope, a moderate to severe reaction, is the result of the development of artery dilation (“vaso”) and/or inappropriate cardiac slowing (“vagal”) leading to a drop in blood pressure with loss of consciousness (van Lieshout, Wieling, Karemaker, & Eckberg, 1991). Kasprisin and colleagues (1992) explain that factors that cause this sudden drop in blood pressure, particularly in the presence of blood loss in blood donation, will increase the likelihood of adverse reactions. Table 1 illustrates a simplified version of the process.

**Fear and Anxiety.** Vasovagal syncope has been described as a “diphasic response” (Graham et al., 1961; Engel, 1978). Although blood donation reactions are commonly believed to occur in two phases, the exact psychological or physiological mechanism(s) responsible for transition from one phase to the next is unclear. Immediately after blood donation has begun, the heart rate is slightly elevated (Jardine et al., 1998). The heart rate likely increases for two reasons. Many times donors see the donation experience as a threat, which activates the body’s “fight or flight” response (the sympathetic nervous system). Such a response may be heightened in those who have a pre-existing fear of blood, needles, or medical situations (Kleinknecht, Kleinknecht, & Thorndike, 1997; Meade, France, & Peterson, 1996). The perceived threat causes the
Table 1

Psychophysiological Responses to Blood Donation

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<td>Pre-Donation</td>
<td>Fear of Needles, Blood, etc.</td>
<td>Sympathetic Nervous System Activation (Elevated Heart Rate, Increased Blood Flow to Skeletal Muscles, Constriction of Peripheral Blood Vessels, etc.)</td>
<td>Nothing, Lightheadedness, Sighing, Yawning, Hyperventilation, Cold or Clammy Perspiration, Feeling Warm or Chilled, Restlessness, Tingling or Numbness in the Face or Extremities, Pallor and Sweating, Mild Nausea, Dizziness, Vomiting or Severe Nausea, Loss of Bladder or Bowel Control, Syncope, Chest Pain, Convulsions, Rigidity, Tremors, and/or Cyanosis.</td>
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<tr>
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<td>Fear and Anxiety</td>
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<tr>
<td>Post-Donation</td>
<td>Relief From the Threat (Needle has been removed)</td>
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heart rate to increase in order to pump blood to the skeletal muscles faster so the person will be physically ready to fight or flee the situation.

Secondly, an acute heart rate increase may occur for physiological reasons, since loss of blood volume will contribute to a drop in blood pressure. This fall in blood pressure occurs at about 30 seconds to 5 minutes into the process (Karp, Weissler, & Heyman, 1961) and is counteracted by elevated heart rate following decreased stimulation of high-pressure baroreceptors (Adler, France, & Ditto, 1991). A significant loss of blood volume, also called hypovolemia, may generate this increased heart rate response. This is a significant problem for many areas of medicine, but the act of donating blood is a common cause. At each donation, individuals in the United States donate 500 ml of blood, which is approximately 10% of their total blood volume (depending on body size). This significant loss of blood triggers a progression of cardiovascular reactions that can in some cases promote negative reactions. As will be described below, low blood pressure, low pulse rate, and low body weight may further exacerbate hypovolemia effects and increase the risk of reactions (Janetzko, Kluter, Kirchner, & Klotz, 2001).

Increased sympathetic activity simultaneously causes increased blood flow to large skeletal muscles and decreased blood flow to the skin and internal organs (with the exception of the lungs and heart). Meanwhile, the increased sympathetic adrenergic activity to the apocrine sweat glands of the skin causes the glands to produce a viscous secretion that can give the skin a clammy feeling.
The second phase of the donation reaction is marked by suppression of sympathetic activity and an increase in parasympathetic activity (van Lieshout et al., 1991). The activation of this phase is accompanied by a fall in heart rate and blood pressure. Because of the changes in cardiovascular status, many blood donors who try to stand at this point (the end of donation) do not have enough cardiac output to sustain their cerebral blood circulation. As a result, they may faint, or have milder reactions such as dizziness or lightheadedness (Trouern-Trend et al., 1999). According to Graham and colleagues (1961), the transition from the presyncopal to syncopal phase is activated by the relief from anxiety that the donor experiences after he/she perceives that the threat has passed. For example, the individual may sense that the threat is over when the needle has been removed. Others may have different cues, such as leaving the donation chair or leaving the clinic. In sum, blood donation places numerous psychophysiological challenges on the donor. Next, I will review empirical studies that have attempted to uncover important predictors of this psychophysiological reaction.

Predictors of Blood Donation Reactions

A variety of physiological, psychological, and demographic factors have been examined as predictors of negative reactions to blood donation. Whereas this literature has evolved over the past 60 years, and has relied on a number of different dependent measures of donor reactions, a number of consistent predictors have emerged.

Demographic Factors

Age, Sex, & Race. Younger donors, usually under 20 years of age, experience reactions more often than older donors (Callahan et al., 1963; Graham, 1961; Greenbury,
although research regarding sex as a predictor of adverse blood donation reactions has been inconsistent, more often sex has been found to have no effect on donor reactions (graham; kasprisin et al.; moloney et al.; ogata et al.; poles & boycott). trouern-trend and colleagues found that, overall, women have more adverse reactions than men. however, when differences in body weight are controlled statistically, women and men have similar experiences, suggesting that apparent sex differences are actually due to body size differences. very little research has been done focusing on race as a predictor of blood donation reactions. graham (1961) briefly noted a significant difference in reaction rates between african american and caucasian participants, indicating that none of the 62 african american donors experienced reactions. this was compared to 17.9% of the 352 caucasian donors who suffered from reactions. a later study found no difference between these two racial groups (callahan et al.). no recent work has been done on race and blood donation reactions.

**donation status.** first-time donors experience significantly more donor reactions than repeat donors (callahan et al., 1963; kasprisin et al., 1992; trouern-trend et al., 1999; ogata et al., 1980; williams, 1942). the stress caused by donating for the first time can lead to increased risk for adverse reactions (gribbon, pickering, sleight, & peto, 1971). for example, anxiety has been shown to contribute to the cardiovascular responses that lead to negative donor reactions (van lieshout et al., 1991). altogether, donating blood for the first time is a reliable test to determine whether a person is prone
to experience reactions. And since donors who experience negative reactions are less likely to return (Kaloupek et al., 1985; Piliavin, 1990), most of the group of donors that returns consists of those not at risk for reactions. Trouern-Trend and colleagues (1999) termed this decrease in negative reactions the “survivor phenomenon.” Although the rate of negative reactions drops dramatically after the first donation, it does not level off until after the fourth donation (Kasprisin et al.). The next section will specify how physiological variables, such as weight, blood pressure, and the amount of blood withdrawn can affect the occurrence of reactions.

Physiological Factors

Weight. Next to donor age, donor body weight is the second leading factor contributing to negative blood donation reactions (Trouern-Trend et al., 1999). Donors who weigh less are more likely to experience adverse reactions (Kasprisin et al., 1992; McVay et al., 1990; Trouern-Trend et al.), which may be attributable to a greater percentage of blood volume lost in smaller donors (i.e., the typical donation of 500 ml represents a greater proportion of total blood volume in a smaller person).

Blood Volume Withdrawn. It is generally established that the incidence of adverse donor reactions and the amount of blood withdrawn are correlated. Poles and Boycott (1942) found that factory workers who had 540 ml of blood withdrawn experienced 4.7% more negative reactions to donation than donors who had just 440 ml withdrawn. Callahan et al. (1963) concluded that blood volume withdrawn has a large effect on the incidence of donor reactions. Their study demonstrated that nearly zero reactions occurred when 250 ml of blood was withdrawn, but approximately 80% of
those who donated 1200 ml of blood experienced reactions. Research on blood
donation in Japan, where 200 ml of blood is withdrawn from each donor (both first-time
and repeat donors), indicates a lower incidence of reactions as compared to American
donors (Ogata et al., 1980).

*Blood Pressure.* Although little research has focused on initial blood pressure
and blood donation reactions, the existing research has demonstrated that both low
diastolic and low systolic blood pressure, prior to donation, are significantly related to
increased reactions (Kasprisin et al., 1992; Ogata et al., 1980). More recently, one study
determined that high blood pressure (systolic over 150 mmHg and diastolic over 90
mmHg) was protective against adverse reactions (Trouern-Trend et al., 1999). As
discussed earlier, blood pressure is the final determinant of cerebral blood flow. Thus,
lower initial blood pressure means less room to drop before perfusion pressure is
insufficient to maintain adequate blood flow to the brain.

Even though demographic and physiological predictors have been established,
they are often of little value to blood collection agencies because they are typically not
acutely amenable to change. Psychological factors, on the other hand, may prove more
helpful in predicting and helping to prevent blood donation reactions.

*Psychological Factors*

In the medical literature on blood donation, minimal attention has been devoted
to psychological predictors of negative reactions to blood donation. However, as noted
above, anticipatory anxiety has been identified as a noteworthy precursor (Graham,
1961). More recently, psychological indices that were not originally developed in the
context of blood donation have been examined as potential predictors of adverse reactions. Researchers have verified that individuals with a history of fainting in response to blood and injury cues report significantly higher scores on the Anxiety Sensitivity Index (Kleinknecht, 1988) and an item on the Fear Survey Schedule regarding fear of human blood (Kleinknecht, 1987). The Anxiety Sensitivity Index, which contains 16 items, measures beliefs about anxiety and alertness to fear-invoking stimuli (Reiss, Peterson, Gursky, & McNally, 1986). The Blood and Injury Fears Subscale of the Fear Survey Schedule measures fear and discomfort associated with situations and stimuli involving bodily injury, death, and illness (Meade et al., 1996). This scale consists of 12 stimuli that the participant must rate on a scale of one “not at all” to five “very much.” In a recent study (Meade et al.), the Blood and Injury Fears Subscale was the best predictor of blood donation reactions in first-time donors ($r=.43$, $p<0.001$). Labus and colleagues (2000) analyzed the predictive power of three subscales of the Medical Fears Survey—fear of injections and blood draws, fear of blood, and fear of mutilated bodies. High scores on the fear of injections and blood draws subscale provided the best predictor of adverse reactions in both first-time ($r=.65$, $p<0.01$) and experienced female blood donors ($r=.34$, $p<0.01$), when compared to the fear of blood and fear of mutilated bodies subscales. The fear of blood subscale was a significant predictor of negative reactions in experienced male donors ($r=.45$, $p<0.01$), but none of the subscales had predictive power for first-time male donors. The Mutilation Questionnaire measures the verbal-cognitive element of blood and injury fear (Kleinknecht & Thorndike, 1990; Meade et al., 1996). It consists of 30 true or false items regarding blood and injury stimuli. Mutilation
Questionnaire scores can be useful in identifying individuals with high anxiety around blood, thus individuals who are more likely to experience negative reactions. The Mutilation Questionnaire is highly correlated with five blood/injury items taken from the Fear Survey Schedule ($r=.75$, $p<0.01$). In addition, the Mutilation Questionnaire is more predictive of fainting than the same blood/injury items from the Fear Survey Schedule items (Kleinknecht & Thorndike) and is the best predictor of fainting for experienced donors ($r=.31$, $p<0.01$; Meade et al.).

**Previous Interventions For Reducing Blood Donation Reactions**

Many of the observed predictors of blood donation reactions do not lend themselves to clear intervention strategies (e.g., age, donor experience, weight). However, other predictors such as amount of blood withdrawn, blood pressure, and anxiety do suggest possible avenues to improve the overall donation experience. Therefore, interventions that target these predictors may be effective at reducing blood donation reactions.

*Volume of Blood Collected.* Collecting a smaller volume of blood, for example, may be effective in reducing the occurrence of negative reactions. In Russia, only 250 ml of blood is drawn at the initial donation (Vaughn, 1967). This amount is then increased 50 ml each subsequent donation, until a maximum of 450 ml is reached. First-time donors reportedly experience fewer negative reactions because the smaller amount of blood that is lost produces a smaller drop in blood pressure (Vaughn). In addition, as fear and anxiety gradually lessen at each future donation, increasingly more blood is drawn each time. The major conclusions that must be considered are: (1) novice donors have a
higher risk for reactions and (2) collecting less blood tends to reduce reactions. Consequently, regulating blood volume withdrawn according to donor risk status should be an effective intervention for reducing reactions. The only limitation is that in order to obtain enough blood to take care of our country’s needs, cutting the amount of blood withdrawn in half is not feasible. Since changing the blood donation procedure is not an option, researchers have looked at time- and cost-effective interventions that donors can use before and/or during donation. Examples of these include distraction, applied muscle tension, and caffeine consumption.

**Distraction.** Distraction has proven to be helpful in alleviating anxiety for individuals undergoing various stressful medical procedures (Corah, Gale, & Illig, 1979; Rickert, Kozlowski, Warren, Hendon, & Davis, 1994; Seyrek, Corah, & Pace, 1984) and has also shown promise as a method for attenuating blood donor reactions (Bonk, France, & Taylor, 2001). In the context of blood donation, distraction includes anything that removes the donor’s attention from the donation procedure, while allowing the phlebotomist to draw blood freely. Examples include listening to music, reading, or talking. In a recent study, Bonk and colleagues (2001) had participants wear a visor and headset so that they could view a three-dimensional audiovisual presentation while undergoing blood donation. In addition to examining the effects of distraction on donation reactions, this study also assessed a hypothesis previously developed by Miller (1980). According to Miller, “blunters” tend to use such strategies as distraction, denial, and reinterpretation during stressful situations, while “monitors” tend to seek relevant information and attend to the situation. Bonk and colleagues’ results showed that those
who prefer blunting coping strategies, as opposed to monitoring coping strategies, benefited from distraction during blood donation by experiencing fewer negative blood donation reactions. There was no effect of distraction on those who preferred a monitoring coping style. Interestingly, many donors use one distraction strategy without realizing it—talking to the phlebotomist. Do donors with talkative phlebotomists experience fewer reactions? The importance of the phlebotomist-donor relationship as a factor in reducing donor reactions has been noted (Ogata et al., 1980), but further research must be done to validate this speculation.

*Applied Muscle Tension.* Applied muscle tension, which involves successive tensing and resting of all of the major muscles of the arms and legs, has been effective in preventing fainting (Ditto, Wilkins, France, Lavoie, & Adler, 2003; Smith, Hudson, & Raven, 1987). The rationale behind this approach is that elevated muscle tensing will attenuate the decrease in blood pressure that results from blood loss (Smith et al.). Smith and colleagues assessed the effect of muscle tension on the cardiovascular responses to lower body negative pressure (i.e., decreased blood pressure), hypothesizing that muscle tension induces a mechanical compression of the vasculature, which in turn results in the maintenance of blood pressure by enhancing cardiac output. In other words, muscle tensing may push blood through the large veins of the arms and legs toward the heart. In their study, 75 percent of the participants experienced pre-syncopal reactions during the relaxed state, but during the elevated muscle tension levels no participants experienced these reactions. Recently, Ditto and colleagues (2003) studied the effects of applied muscle tension on reducing negative physiological reactions during blood donation.
Results showed that individuals who were taught applied muscle tension, with the exception of first-time male donors, reported significantly fewer negative donation reactions than the group that was not taught this technique. It should be noted that, besides being a physiological intervention, muscle tension is also a psychological intervention. Muscle tensing is a form of distraction because it allows the donor to concentrate on tensing their muscles and thereby may take their mind off of the actual situation, which may reduce anxiety and fear.

**Caffeine.** Caffeine consumption prior to donation has also been successful at attenuating subjective reactions to blood donation (Kasprisin et al., 1992; Sauer & France, 1999). A possible reason that caffeine is effective is because it is a vasoconstrictor, and therefore it can offset the reductions in blood pressure associated with blood loss. Sauer and France (1999) found that those who consumed 250 mg of caffeine prior to donation, compared to no caffeine or a smaller dose of 125 mg, reported significantly less negative physiological reactions. In addition, these donors had their chairs reclined fewer times and indicated a greater likelihood of donating again in the future. While consuming 250 mg of caffeine has moderated cardiovascular responses to blood donation, it is noted that too much caffeine may significantly increase subjective anxiety leading to reactions.

The advantage of such intervention strategies as distraction, applied muscle tension, and caffeine consumption is that they can be practiced in conjunction with each other. An important feature of all reaction-reducing strategies is their capacity to psychologically or physiologically maintain blood pressure. The current study will focus
on yet another simple intervention that may be used to maintain blood pressure—pre-donation hydration.

*Hydration and Blood Donation*

As noted above, blood donation is associated with a loss of approximately 10% of total blood volume. Because of this fact, it is medically necessary to rehydrate donors to help replace the fluid lost during donation, and therefore they are required to drink at least a cup of fluid after donation. Although post-donation fluid replacement is useful, it may be preferable to consume fluid shortly before donating, as this may help to prevent the negative reactions that can accompany acute reductions in blood volume. As a result, the present investigation is the first study of the effects of fluid loading donors prior to donation and whether or not it is related to the experience of negative reactions.

*Fluid Loading.* Since many people do not consume a sufficient amount of water per day (Heller, Sohn, Burt, & Eklund, 1999), we would expect that many donors are already hypohydrated when they show up to donate. Therefore, the state of hypovolemia that is brought about by the act of donating blood may be made worse by the lack of proper hydration. In fact, being well hydrated (by drinking water), as opposed to hypohydrated, has been shown to produce cardiovascular responses such as constriction of the arteries (Routledge, Chowdhary, Coote, & Townsend, 2002). Constricting arteries may offset the rapid decrease in blood pressure that results from the reduction in blood volume during blood donation.

To date, there exists no research on fluid loading as a reaction-reducing intervention in the context of blood donation, yet fluid loading has been found to be
effective for syncope in other contexts. For example, researchers have examined fluid loading as a treatment for children who experience vasodepressor syncope (Younoszai, Franklin, Chan, Cassidy, & Allen, 1998). In this study, patients from a pediatric cardiology outpatient clinic were given an intravenous bolus of isotonic saline solution. After the bolus, those who fainted in response to a tilt-table test were prescribed a protocol of oral fluid therapy. Tilt tables are bed-like tables that can be raised and lowered at varying speeds and degrees. While receiving fluid therapy, ninety percent of the subjects (N=58) experienced no syncope in response to table tilt. The researchers concluded that it is probable that fluid loading maintains blood pressure, thus preventing any sudden drop in blood pressure that would impede flow of blood to the brain. For those who received fluid therapy but experienced syncope, reactions occurred significantly later in time than for those with no fluid therapy.

Recently, at the American Heart Association’s 56th Annual High Blood Pressure Research Conference, two teams of researchers reported that fluid loading reduced syncope in adults who underwent tilt-table testing (Schroeder, Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002; Lu et al., 2002). Both research teams had participants lie on tilt tables that started parallel to the floor and then tilted to a 60-degree head-up angle. Lu’s team gave their 22 subjects 16 ounces of water five minutes prior to the tilt test. A randomized counterbalanced design was used in which one group consumed water on the first day of testing and the other did not and the two groups switched on the second day. Heart rate, blood pressure, cardiac output, and total peripheral vascular resistance were continuously monitored to determine tolerance.
These researchers found that, of those who consumed water, only one person experienced pre-syncopal reactions. This was compared to the 10 of 22 participants who did not drink water and experienced reactions (e.g., more significant decrease in heart rate). Tolerance to tilt was on average 33 minutes without fluid loading versus 41 minutes with fluid loading. Similarly, Schroeder’s team measured finger blood pressure, brachial blood pressure, heart rate, thoracic impedance, and blood flow velocity in the brachial artery and determined tolerance by the amount of time to presyncope. Results revealed that participants who consumed 500 ml of water, compared to the 50 ml of water consumed in the control group, demonstrated increased tolerance to the tilt test by 5±1 minutes. These data suggest that oral fluid therapy is an effective treatment for vasovagal syncope. Can this finding be generalized to include syncope as a result of significant blood loss due to blood donation? To answer this question, we must first understand cardiovascular responses to fluid loading.

Physiological Effects of Fluid Loading. As previously stated, being well hydrated has been shown to produce cardiovascular responses such as constriction of the arteries (Routledge et al., 2002), thus could potentially offset the rapid decrease in blood pressure that results from the reduction in blood volume during blood donation. Routledge and colleagues (2002) looked at the effects of drinking 500 ml of water on heart rate, blood pressure, and other cardiovascular responses. The researchers found that blood pressure remained stable and heart rate decreased (maximal decrease occurred 20 minutes after drinking). Also previously summarized, Younoszai and colleagues (1998) found that increased body water volume from fluid loading prohibited any sudden drops in blood
pressure during tilt-table testing. Findings from the tilt-table testing studies mentioned above have demonstrated that fluid loading diminishes increases in heart rate and decreases in stroke volume, slightly increases blood pressure as a result of increased total peripheral resistance, and improves cerebral blood flow. In general, the most obvious and perhaps relevant finding that can be drawn from this literature is that fluid loading maintains or slightly increases blood pressure. Again, this is important because as long as blood pressure remains stable cerebral perfusion is maintained.

The literature explaining the specific physiological causes of cardiovascular changes in response to fluid loading is small. Jordan and colleagues (2000) studied the mechanisms that could increase blood pressure with water drinking. Specifically, venous blood samples were obtained to determine hematocrit, plasma catecholamines (i.e., norepinephrine), vasopressin, and plasma renin activity. Consistent with previous research (Lu et al., 2002; Schroeder, Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002), blood pressure increased after drinking water. This pressor response was evident within 5 minutes after drinking started, reached a maximum after approximately 30-35 minutes, and continued for greater than 60 minutes. In addition, consuming 480 ml of water caused a greater pressor response than consuming 240 ml of water. The only specific cardiovascular mechanism that responded to water was plasma norepinephrine, which increased 30 minutes after drinking water. In fact, plasma norepinephrine levels were increased as much after water consumption as they are increased by nicotine (Benowitz, 1986; Cryer, Haymond, Santiago, & Shah, 1976) and caffeine (Robertson et al., 1978). Plasma renin activity, vasopressin, and plasma volume were not affected by
water consumption. In general, increased body water from fluid loading increases baroreceptor sensitivity (Schroeder, Bush, Norcliffe, Luft, Tank, Jordan, & Hainsworth), which triggers an increase in plasma norepinephrine levels. Increased plasma norepinephrine levels may result in increased blood pressure because norepinephrine is a vasoconstrictor. In other words, norepinephrine can stimulate contraction of arteries and capillaries, thus increasing blood pressure and cerebral perfusion. In sum, fluid loading has been effective in maintaining blood pressure, thus preventing fainting, in contexts other than blood donation.

Timing of fluid responses. It is clear that the body attempts to compensate for lost blood volume very quickly (i.e. within minutes of donating). Janetzko and colleagues (2001) measured total body water before and after blood donation and found a rapid shift of on average 208 ml of water from the interstitial to the intravascular compartments after an average of 6.6 minutes. Results from a study of cats demonstrated that, 10 minutes after 15 percent of the cats’ blood volume was drained, 33 percent of the fluid was already replaced and 66 percent was replaced after 45 minutes (Hillman & Lundvall, 1981). Despite this knowledge, the most optimal time to drink water to prevent the possible decrease in blood pressure that can accompany blood donation remains unclear. Although intravascular fluid compensation occurs quickly, negative reactions to donation can occur both before and after a fluid shift occurs. Although there are no previous studies to provide specific guidelines on the appropriate timing of successful fluid loading for blood donors, it seems to make the most sense to follow the guidelines set by the existing fluid loading studies. According to the Jordan et al. (2000) study, the pressor
response to drinking water was evident within 5 minutes after drinking started, reached a maximum after approximately 30-35 minutes, and continued for greater than 60 minutes, suggesting that it may be most beneficial to fluid load blood donors 30-35 minutes prior to donating. Lu and colleagues (2002) fluid loaded their participants 5 minutes prior to a tilt test and found that those who received fluid fainted after an average of 40.9 minutes, compared to 33.0 minutes for those who did not. Furthermore, as noted earlier, Schroeder and colleagues (2002) fluid loaded their participants 15 minutes prior to a tilt test and reported that drinking water improved orthostatic tolerance (determined as the amount of time to presyncope) by 5±1 minutes. Once again, it may be more important that water consumption occurs prior to donating than that it is timed perfectly. With that said, is it possible that blood donors with higher initial body water are protected from sudden decreases in blood pressure during donation?

*Total body water.* Although there is no literature on the cardiovascular responses in blood donors with increased hydration status, recent research has investigated hydration status in other contexts. One study examining long-term fluid hydration status indicated that increased total body water is related to decreased cardiovascular reactivity during passive physical challenge (i.e., posture change) and unrelated to cardiovascular reactivity during passive psychological challenge (i.e., viewing an open-heart surgery; Patterson, Simons, France, & Tulodzieski, 2001). Specifically, higher total body water was related to increased heart rate and increased cardiac output in response to standing. It was speculated that body water was unrelated
to cardiovascular reactivity during the passive psychological challenge because it was a weak stressor, thus further research using a more severe stressor is needed.

In sum, fluid loading in other contexts has been found to prohibit decreases in blood pressure that lead to negative reactions such as syncope. Additionally, there is evidence that increased hydration status produces cardiovascular responses similar to fluid loading for individuals during posture change. Thus, it is possible that baseline hydration levels are inversely correlated with the likelihood of blood donation reactions, with lower total body water resulting in a greater likelihood that a donor will experience subjective physiological reactions.

Statement of Problem and Hypotheses

Based on the existing evidence that water loading contributes to increased resting blood pressure, the present study examined fluid loading as a time- and cost-effective means of attenuating negative physiological reactions to blood donation. A randomized, controlled trial was used in which donors either did or did not receive 500 ml of water 30 minutes prior to their first donation. In addition, bioimpedance analysis was conducted for both the intervention and control groups approximately one hour prior to donation to examine the contribution of total body water levels to likelihood of donor reactions. Figure 2 illustrates a hypothetical model of the cardiovascular effects of pre-donation hydration status.

Based on prior research, it was hypothesized that:

1. Compared to participants who received no fluid before donation, those who received 500 ml of water prior to donation would:
Figure 2

*Proposed Model of Reduction of Negative Reactions as a Function of Pre-Donation Hydration Status*

Blood Donation → Loss of ~10% blood volume

- **Hydrated**: Blood pressure maintained or increased due to arterial constriction → Reduced risk for vasovagal reactions
- **Hypohydrated**: Blood pressure decreased → Increased risk for vasovagal reactions
a) Have lower total scores on the Blood Donation Reactions Inventory (sum of items #1-11).

b) Report fewer phlebotomist interventions (sum of items #13 a-i on the Blood Donation Reactions Inventory).

c) Report an increased likelihood of giving blood again (items #14 a and b on the Blood Donation Reactions Inventory).

2. Within the intervention and control groups, total body water measured at pre-donation would be inversely correlated with total scores on the Blood Donation Reactions Inventory (sum of items #1-11).

3. The intervention would interact with pre-donation total body water, such that the lower total scores on the Blood Donation Reactions Inventory (sum of items #1-11) would be observed in those with high total body water who received 500 ml of water prior to donating.

METHODS

Power Analysis

Previous studies looking at various behavioral and pharmacological interactions for first-time donors, and using the Blood Donation Reactions Inventory as the outcome variable, revealed effect sizes ranging from .25-.40 (Bonk et al., 2001; Ditto et al., 2003; Sauer et al., 1999). Because there are no existing studies on the effects of water loading on donation reactions, an intermediate effect ($f = .325$) was hypothesized for the current study. Using a between-groups F-test comparison to calculate power estimates, and
based on an anticipated effect size of \( f = .325 \) and \( \alpha = 0.05 \), it was estimated that a total sample of 77 participants would be required to achieve a power of 0.80 in a two-groups design. Therefore, the current study aimed to recruit at least 40 participants per group.

**Participants**

The final sample for this study included 83 individuals who had never donated blood before. Participants consisted of 43 males and 40 females who ranged in age from 18 to 26 years, with an average age of 19 years (SD = 1.1). Because it was anticipated that a number of participants would be deferred from donation by the American Red Cross for health reasons (e.g. acute illness, low iron), a total of 118 donors were initially recruited to assure a total sample of at least 77 participants. Twenty-three of these participants never showed up to donate and 12 (3 men and 9 women) were deferred from donation by the American Red Cross, resulting in a final sample of 83 participants (43 fluid loaded, 40 not fluid loaded). The numbers of participants scheduled and registered to donate and who completed donation are illustrated in Table 2.

**Apparatus**

*Body Water Measurement:* Bioelectrical impedance analysis is based on “the theoretical relation between the volume of a conductor (human body), the length of a conductor (stature), the components of a conductor (fat and fat-free mass), and the impedance of a conductor” (Jurimae, Jurimae, & Pihl, 2000). Multiple-frequency
Table 2

Total Participants at Various Stages of the Study as a Function of Experimental Group and Sex

<table>
<thead>
<tr>
<th></th>
<th>Water Group</th>
<th>No Water Group</th>
<th>Total Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
</tr>
<tr>
<td>Scheduled to donate</td>
<td>34</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Registered to donate</td>
<td>31</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Completed study</td>
<td>29</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>
analyzers can differentiate between total and extracellular fluid compartments of the human body (Deurenberg, Weststrate, Paymans, & van der Kooy, 1988). This is based on the current flow at low frequencies (5 kHz) passing mostly through extracellular fluids (assessing extracellular body water (EBW)), and at higher frequencies (200 kHz) penetrating all body tissues (assessing total body water (TBW)). Intracellular body water (IBW) is determined arithmetically by subtracting extracellular body water from total body water. Extracellular, intracellular, and total body water are expressed in liters of water. The current study utilized Multiscan 5000 multifrequency bioelectrical impedance monitors (BodyStat Ltd., Isle of Man, UK) to measure each participant’s total, extracellular, and intracellular body water.

Bioelectrical impedance analysis has been a useful tool in assessing human body composition. It has been proposed for measuring fat-free mass (Rubiano, Nunez, & Heymsfield, 2000), percent fat (Brodie, Moscrip, & Hutcheon, 1998), body water changes (Sakamoto et al., 1999), body cell mass, total body water, intracellular body water, and extracellular body water (Hannan, Cowen, Plester, & Fearon, 1998; Jurimae et al., 2000; Schoeller, 2000; Simpson et al., 2001; Thomas, Cornish, Ward, & Jacobs, 1999). The reason this method is so appealing is because it is noninvasive, reliable, easy, safe, and relatively inexpensive to use (Brodie et al.; Lukaski, 1999).

Research using bioelectrical impedance analysis has revealed that this method is valid qualitatively and quantitatively (Armstrong et al., 1997; Deurenberg, Tagliabue, & Schouten, 1995; Ellis & Wong, 1998; Kushner, Schoeller, Fjeld, & Danford, 1992; Lukaski, 1999; Patel, Peterson, Silverman, & Zarowitz, 1996). This method has been
shown to have high test-retest reliability, with total body water \( r = .99, p<.0001, n = 100 \), extracellular body water \( r = .99, p<.0001, n = 99 \), and intracellular body water \( r = .99, p<.0001, n = 99 \) significantly correlated over a period of one week (Shanholtzer & Patterson, 2003). Correlation analysis between bioelectrical impedance analysis and body water compartment volume, in healthy individuals with altered body water due to an infusion of an electrolyte-containing fluid (Lactated Ringer’s solution) or a diuretic that induced rapid fluid loss, have been significant and comparable for five models of bioelectrical impedance analysis, with Pearson correlation coefficients, for total, extracellular, or intracellular body water, of 0.75 to 0.97 (Schoeller, 2000). Furthermore, results from a recent study reveal that bioelectrical impedance is able to detect acute changes in body water in as little as one hour after water is consumed (Shanholtzer & Patterson, in press). However, it must be noted that bioelectrical impedance measurements can be influenced by factors such as skin temperature, the menstrual cycle, use of oral contraceptives, body positions, prior food, and exercise-induced dehydration (Brodie et al., 1998), hence data may be more accurate if these variables are recorded and/or controlled. The present study was interested primarily in the influence of total body water. However, if there was a significant influence of total body water, exploratory analysis would then be conducted to examine extracellular and intracellular body water as potential predictors of donor reactions.

**Blood Pressure:** Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured using an automated oscillometric blood pressure monitor (Dinamap Compact T). The accuracy of this measure is ±3.5 percent.
Materials

Data record: A data record form was used at pre-donation (Appendix D). This form included exclusion questions, including whether or not the participant was taking prescription medications or had any major health problems. Each participant’s diet, specifically what the person had to eat and drink that day (including amounts), was recorded on this form. Next, information that would be entered into the bio-electrical impedance monitors was obtained and recorded. This information included basic demographic information (i.e., age, height, weight) and cardiovascular measures (i.e., blood pressure, heart rate). For the participants in the intervention group that did not drink all 500ml of water, the remaining amount was recorded on this form. The impedance reading was recorded on this form at a different time (e.g., after the information had been downloaded to the computer).

Blood Donation Reactions Inventory: (Appendix E) The Blood Donation Reactions Inventory was developed for a study that attempted to predict negative physiological reactions (e.g. syncope, dizziness) in blood donors (Meade et al., 1996). The Blood Donation Reactions Inventory consists of 11 subjective physiological reactions that participants rate on a scale of 0 (not at all) to 5 (to an extreme degree). The reactions include faintness, dizziness, weakness, facial flushing, visual disturbance, difficulty hearing, lightheadedness, rapid or pounding heartbeat, sweating, rapid or difficult breathing, and nausea or upset stomach. Thus, total scores range from 0-55. This scale has demonstrated high internal consistency (alpha = .93), and total scores are significantly positively correlated ($r = .46$) with phlebotomist ratings of adverse donor
reactions (Meade et al.). The Blood Donation Reactions Inventory has been used in prior studies that have shown significant effects of distraction (Bonk et al., 2001), caffeine (Sauer & France, 1999), and applied muscle tension (Ditto et al., 2003) on reactions in first-time blood donors.

For descriptive purposes, this scale includes an item (item #12) that asks whether the participant lost consciousness. Because this is a rare event, it is rarely used in statistical analyses. To provide an objective index of severity of reactions, as judged by an external expert (i.e., the phlebotomist), yes-or-no items have been added to the Blood Donation Reactions Inventory concerning whether or not the donor fainted or the phlebotomist made any specific decisions or adjustments during donation. Item 13 (a-i) includes a series of questions that measures whether or not the phlebotomist intervened. More specifically, the participant chooses “yes” or “no” to a list of common phlebotomist interventions that consist of the following: “At the clinic today, did anyone…(a) recline your donation chair (to raise your legs at or above heart level), (b) help you get from your donation chair to a recovery area, (c) have you breathe into a paper bag, (d) have you put your head between your knees, (e) apply a cold compress to your forehead or neck, (f) have you loosen any tight or restrictive clothing, (g) instruct you to take a deep breath and then cough, (h) give you any form of first aid, and (i) remove your donation needle because you lost consciousness.” Item 14 (a-b) assesses participant intentions to donate in the future. Finally, in the present study, participants were asked about the use of a variety of potential coping strategies, including fluid consumption and distraction (Appendix F).
**Procedure**

*Initial screening:* Participants were recruited through introductory psychology courses at Ohio University. The preliminary screening selection criteria included: willingness to donate blood, no major health problems, the use of no medications (except oral contraceptives), having received no tattoos or body piercings within the past year, and not being pregnant (Appendix A). Upon completion of the preliminary screening forms, participant forms were randomly pulled from the pile of screening forms that had been marked “yes,” indicating an agreement to participate in the study. The primary investigator then called all selected participants and invited them to attend one of four information sessions. Two information sessions discussed the control condition and the other two discussed the experimental condition (this was predetermined so that participants would blindly assign themselves to the treatment or no treatment condition based on what fit best with their schedules). The steps of the procedure are described in Table 3.

*Information session:* All participants were asked to attend a 30-minute information session approximately one to seven weeks before donating for the first time. Each meeting began by reviewing the exclusion criteria (Appendix B) for the study. The exclusion criteria were shown in the front of the room on an overhead projector. The criteria included whether or not they had donated blood before, had any major health problems, were taking any prescription medications, had gotten a tattoo or piercing in the past year, and were pregnant or think they could have been pregnant. Participants who
Table 3

Procedural Steps

<table>
<thead>
<tr>
<th>TIME</th>
<th>EVENT</th>
<th>PLACE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-7 week(s) pre-donation</td>
<td>Information Session</td>
<td>Psychology Department</td>
<td>Procedures explained and informed consent obtained.</td>
</tr>
<tr>
<td>~1 hour pre-donation</td>
<td>Physiological Monitoring and Fluid Loading</td>
<td>Laboratory</td>
<td>Both groups—Total body water assessed and systolic and diastolic blood pressure obtained. Intervention group—500ml of water consumed.</td>
</tr>
<tr>
<td>~1 hour after bio-impedance and blood pressure readings</td>
<td>Blood Donation</td>
<td>Blood Donation Site</td>
<td>All participants will go through the blood donation procedure.</td>
</tr>
<tr>
<td>Immediately after donation</td>
<td>Post-Donation</td>
<td>Laboratory</td>
<td>All participants will complete a questionnaire concerning their blood donation experiences and future intentions.</td>
</tr>
</tbody>
</table>
did not meet the criteria were instructed that they would receive one experiment point for attending the meeting, but would not be permitted to continue with the study. For those who met the criteria, the experimental procedures were explained and informed consent forms (Appendix C) were distributed and obtained from interested participants. There were two versions of the informed consent form—one describing the procedures for the water group and one describing the procedures for the no water group. Participants were unaware of the other experimental condition because all participants present at each individual information session were assigned to the same group. Next, participants signed up to donate blood at one of three university blood drives during the quarter. Experiment sign-up schedules were passed around to the participants and they chose times that fit their schedules. Participants were signed up at twenty-minute intervals—the control group and the fluid loading group were scheduled on every other twenty-minute interval. The time on the sign up sheet referred to the time in which each participant arrived at the laboratory on the day of donation. The minimum goals for each condition were 25 fluid loaded per sex and 25 not fluid loaded per sex. All participants received one point each for attending the meeting. A few days prior to each blood drive, each participant was reminded via email and a telephone call of their appointment to meet at the laboratory.

**Physiological monitoring and water loading:** At scheduled times, 60 minutes before donation, individual participants arrived at the laboratory. In order to prevent between-group contamination, the laboratory door was closed and only the experimenter and the current participant were present in the room. All water bottles were hidden from
sight so that participants in the no water group never saw them. Prior to measuring total body water, height (in cm) and weight (in kg) were obtained. After a five-minute resting period, one blood pressure (in mmHg) and heart rate (in bpm) measurement was obtained using the Dinamap Compact T blood pressure monitor with an appropriately sized cuff applied over the upper bicep of the left arm. The five-minute resting period and the blood pressure reading were taken while the participant was sitting upright. After another five-minute resting period in which participants were lying down, total, extracellular, and intracellular body water were assessed using the electrical bio-impedance monitors (BodyStat Ltd.).

Bioelectrical impedance analysis measures the resistance and conductance of a weak electrical current that is passed through the body. As can be seen in Figure 3, resistance is measured across two adhesive surface electrodes placed on the right foot (one behind the toes and one on the ankle at the level of and between the medial and lateral malleoli) and two electrodes on the right hand (one behind the knuckles and one on the wrist next to the ulnar head). The room was arranged to ensure that no metal was close to the participant that could influence impedance readings (e.g., jewelry, testing bed or chair; Brodie et al., 1998). Participants remained supine with their arms and legs spread slightly apart and no body parts touching one another (e.g., inner thighs) during the recording period.

Once basic demographic (i.e., gender, age) and health variables (i.e., heart rate, blood pressure) had been entered into the impedance monitor, testing began. Participants
Electrode Placements

The figure on the left shows two electrodes placed behind the toes on the ankle at the level of and between the medial and lateral malleoli. The figure on the right shows two electrodes placed behind the knuckles and on the wrist next to the ulnar head.
were tested at three frequencies (5, 50, and 200 kHz), which required approximately 20 seconds to complete. The raw outputs were visible immediately on the analyzer and then transmitted to a host computer that processed the data.

Following the bioelectrical impedance assessment, all participants received the same treatment (except for the water manipulation). Participants were instructed to wait for ten minutes while three seated, resting blood pressure measurements were obtained. These blood pressure measurements were not recorded, which is a limitation that will be discussed later. During this ten-minute waiting period, participants in the water group consumed 500 ml of bottled water. If they did not finish the entire bottle, the amount of water remaining was recorded. Everyone in the final sample consumed the full 500 ml of water.

**Blood donation:** Participants were given a map and directions to the blood drive location. Once they arrived, participants went through a standard donation protocol. The process of donating blood took approximately one hour. Participants checked in (they had already been registered to donate) and went through the screening procedures. During the first step, the interview, a trained technician reviewed the donor's health history information. After the interview, the blood collection staff member checked the donor's blood pressure, pulse rate, temperature, and iron level. If they were eligible to donate, they proceeded to the donation chair to give blood (if not, they returned to the laboratory to be debriefed and to receive their experiment points). During donation, donors were seated in a semi-reclined position and 500 ml of blood was drawn (unless adverse reactions prevented this). Once donation was complete, participants were
directed to a refreshment area where they were required to have something to eat and drink.

Post-donation: Once each participant was given permission by the blood drive staff to leave the blood donation site, they returned to the laboratory. At the laboratory, participants completed a series of questions concerning donor and phlebotomist reactions during and after blood donation as well as their intention to donate in the future (Blood Donation Reactions Inventory [Appendix E]). Lastly, participants received three research credit points each (in addition to the one point given at the information meeting) for participation in the study.

RESULTS

Statistical Analysis

Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Scores on The Blood Donation Reactions Inventory (as measured by the sum of items #1-11 on the Blood Donation Reactions Inventory) were characterized by positive skew (skew = 1.552; SE skew = .266) and therefore the scores were transformed using log transformations (i.e., log BDRI + 1). The remaining analyses used the log-transformed Blood Donation Reactions Inventory scores. Prior to further statistical analyses, zero-order correlational analyses were calculated between Blood Donation Reactions Inventory score and age, body mass index, heart rate, systolic and diastolic blood pressure, and total, extracellular, intracellular, and percent total body water. As can be seen in Table 4, none of these variables was significantly
Table 4

Results of Zero-order Correlations Conducted on Blood Donation Reactions Inventory Score and Demographic and Biomedical Variables

Note. The blood pressure values were calculated from the single blood pressure measurement taken prior to the pre-donation body water assessment.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Units</th>
<th>Blood Donation Reactions Inventory score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>(years)</td>
<td>.00</td>
</tr>
<tr>
<td>Body mass index</td>
<td>(kg/m²)</td>
<td>-.03</td>
</tr>
<tr>
<td>Heart rate</td>
<td>(bpm)</td>
<td>.18</td>
</tr>
<tr>
<td>Systolic blood pressure</td>
<td>(mmHg)</td>
<td>.07</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>(mmHg)</td>
<td>.20</td>
</tr>
<tr>
<td>Total body water</td>
<td>(L)</td>
<td>-.17</td>
</tr>
<tr>
<td>Extracellular body water</td>
<td>(L)</td>
<td>-.17</td>
</tr>
<tr>
<td>Intracellular body water</td>
<td>(L)</td>
<td>-.16</td>
</tr>
<tr>
<td>% Total body water (TBW/weight)</td>
<td>(%)</td>
<td>.03</td>
</tr>
</tbody>
</table>
correlated with Blood Donation Reactions Inventory score, and therefore none was used as a covariate for the remaining analyses.

The current study utilized several data analytic strategies. First, analysis of variance (ANOVA) was used to examine the effects of water loading on blood donation reactions. Second, nonparametric tests were conducted to determine group differences in phlebotomist interventions reported (Chi-square test) and donor likelihood of donating blood again (Mann-Whitney U test). Next, Pearson correlation was used to examine the relationship between percent total body water, extracellular body water, and intracellular body water and the dependent measure of total score on the Blood Donation Reactions Inventory within (a) the no water group and (b) the water group. Lastly, a hierarchical regression analysis was conducted to examine prediction of total scores on the Blood Donation Reactions Inventory using the water loading manipulation, the total body water estimate, and the interaction of these two variables.

Assessment of Group Differences in Demographic and Biomedical Variables

Demographic and biomedical characteristics of participants in each group for each sex are provided in Table 5. A series of 2 Group X 2 Sex ANOVA’s revealed that women were significantly smaller (indicated by body mass index), $F(1, 79) = 8.79, p < .001, \eta_p^2 = .10$, had lower systolic blood pressure, $F(1, 79) = 35.13, p < .001, \eta_p^2 = .31$, had lower diastolic blood pressure, $F(1, 79) = 5.36, p = .02, \eta_p^2 = .06$, and had lower total body water levels, $F(1, 79) = 111.95, p < .001, \eta_p^2 = .59$, than men (see Table 6 for results
Table 5

Means and Standard Deviations of Demographic and Biomedical Variables of First-time Donors Who Received 500ml or 0ml of Water Prior to Blood Donation

Note. The blood pressure values were calculated from the single blood pressure measurement taken prior to the pre-donation body water assessment. BMI = Body mass index; SBP = Systolic blood pressure; DBP = Diastolic blood pressure; TBW = Total body water.

<table>
<thead>
<tr>
<th>Units</th>
<th>Water Group</th>
<th>No Water Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male (n = 29)</td>
<td>Female (n = 14)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>19.2 (0.8)</td>
<td>19.2 (0.9)</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>26.1 (4.1)</td>
<td>23.0 (2.4)</td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>78.9 (13.8)</td>
<td>81.9 (16.0)</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>131.3 (14.4)</td>
<td>115.6 (12.3)</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>70.2 (7.4)</td>
<td>67.2 (6.5)</td>
</tr>
<tr>
<td>% TBW (%)</td>
<td>0.51 (0.06)</td>
<td>0.48 (0.05)</td>
</tr>
</tbody>
</table>
Table 6

Results from Statistical Tests Conducted on Demographic and Biomedical Variables

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Units</th>
<th>Factor</th>
<th>$F$</th>
<th>$df$</th>
<th>Partial $\eta^2$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>(years)</td>
<td>S</td>
<td>0.86</td>
<td>1, 79</td>
<td>0.01</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>0.03</td>
<td>1, 79</td>
<td>0.00</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>0.68</td>
<td>1, 79</td>
<td>0.01</td>
<td>0.41</td>
</tr>
<tr>
<td>Body mass index</td>
<td>(kg/m²)</td>
<td>S</td>
<td>8.79</td>
<td>1, 79</td>
<td>0.10</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>4.84</td>
<td>1, 79</td>
<td>0.06</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>0.00</td>
<td>1, 79</td>
<td>0.00</td>
<td>0.98</td>
</tr>
<tr>
<td>Heart rate</td>
<td>(bpm)</td>
<td>S</td>
<td>1.02</td>
<td>1, 79</td>
<td>0.01</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>1.33</td>
<td>1, 79</td>
<td>0.02</td>
<td>0.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>0.01</td>
<td>1, 79</td>
<td>0.00</td>
<td>0.91</td>
</tr>
<tr>
<td>SBP</td>
<td>(mmHg)</td>
<td>S</td>
<td>35.13</td>
<td>1, 79</td>
<td>0.31</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>6.70</td>
<td>1, 79</td>
<td>0.08</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>1.35</td>
<td>1, 79</td>
<td>0.02</td>
<td>0.25</td>
</tr>
<tr>
<td>DBP</td>
<td>(mmHg)</td>
<td>S</td>
<td>5.36</td>
<td>1, 79</td>
<td>0.06</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>4.03</td>
<td>1, 79</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>0.38</td>
<td>1, 79</td>
<td>0.01</td>
<td>0.54</td>
</tr>
<tr>
<td>% Total body water</td>
<td>(%)</td>
<td>S</td>
<td>5.97</td>
<td>1, 79</td>
<td>0.07</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>1.47</td>
<td>1, 79</td>
<td>0.02</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S x G</td>
<td>0.11</td>
<td>1, 79</td>
<td>0.00</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Note. SBP = Systolic blood pressure; DBP = Diastolic blood pressure; S = Sex; G = Group; S x G = Interaction term of Sex and Group. The blood pressure values were calculated from the single blood pressure measurement taken prior to the pre-donation body water assessment.
from statistical analyses). In addition, the water group was significantly smaller, $F(1, 79) = 4.84, p = .03, \eta^2_p = .06$, had lower systolic blood pressure, $F(1, 79) = 6.70, p = .01, \eta^2_p = .08$, and had lower diastolic blood pressure, $F(1, 79) = 4.03, p = .05, \eta^2_p = .05$, than the no water group. There were no other significant main effects or interactions.

**Analysis of Group Differences in Blood Donation Reactions**

A 2 Group X 2 Sex ANOVA was conducted to explore the effect of sex and pre-donation water on Blood Donation Reactions Inventory score. As can be seen in Figure 4, there was a significant main effect for group, $F(1, 79) = 11.81, p = .001$, reflecting lower reaction scores in those who received pre-donation water. Neither the main effect for sex, $F(1, 79) = .65, p = .42$, nor the group by sex interaction, $F(1, 79) = .23, p = .63$, was significant, indicating similar donation reactions in men and women.

**Analysis of Group Differences in Phlebotomist Interventions Reported**

To assess the hypothesis that participants in the pre-donation water group would report fewer phlebotomist interventions (as measured by the sum of items #13 a-i on the Blood Donation Reactions Inventory) than participants in the no water group, a 2 group (water, no water) Chi-Square analysis was conducted on total number of phlebotomist interventions. A significant difference was not observed between the groups, $X^2(1, N = 82) = 0.36, p = .65$, with 40% of the water group and 46% of the no water group reporting receiving at least one of the interventions. Likewise, as illustrated in Figure 5, none of the nine individual interventions were statistically significant between the groups.

**Analysis of Group Differences in Likelihood of Future Donations**

It was hypothesized that participants in the water group would report an
Figure 4

Mean (± SEM) Blood Donation Reactions Inventory (BDRI) Scores as a Function of Experimental Group (Water, No Water) and Sex
Figure 5

Percentages of Phlebotomist Interventions as a Function of Experimental Group (Water, No Water)
increased likelihood of giving blood again for both themselves (Blood Donation Reactions Inventory item #14 a) and others (Blood Donation Reactions Inventory item #14 b) as compared to participants in the no water group. However, results of separate Mann-Whitney U tests, conducted separately for each sex, revealed no significant differences between the water and no water groups with regard to likelihood of future donation for self or others. Results of these statistical analyses are provided in Table 7.

Analysis of Total Body Water and Blood Donation Reactions

Results of a correlation analysis revealed that total body water at pre-donation was not significantly correlated with Blood Donation Reactions Inventory scores for either the water group, \( r(42) = -.10, p = .53 \), or the no water group, \( r(39) = -.12, p = .47 \). Nonetheless, because pre-donation water loading may interact with pre-donation total body water to affect Blood Donation Reactions Inventory scores, a hierarchical regression analysis was conducted to examine the prediction of total scores on the Blood Donation Reactions Inventory using pre-donation water (yes, no), total body water estimate, and the interaction of these two variables. Using a forward stepwise procedure, both the intervention manipulation and total body water were offered as possible predictors on step 1. On step 2 of the analysis, the interaction of the intervention manipulation and total body water was offered as a potential predictor. Results of this analyses indicated that the water loading intervention was the only significant predictor of Blood Donation Reactions Inventory total score, \( R^2 = .16, F(1, 81) = 15.40, p < .001 \), and thus was the only variable in the final model.
Results from Mann-Whitney U Tests on the Likelihood of Future Donation for “Self” and “Others” as a Function of Experimental Group (Water, No Water) and Sex

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>No Water</th>
<th>$z$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self</td>
<td>Male</td>
<td>74.9 %</td>
<td>62.7 %</td>
<td>-1.55</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>80.7 %</td>
<td>78.0 %</td>
<td>-0.14</td>
</tr>
<tr>
<td>Other</td>
<td>Male</td>
<td>67.1 %</td>
<td>63.3 %</td>
<td>-0.68</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>66.2 %</td>
<td>71.4 %</td>
<td>-0.72</td>
</tr>
</tbody>
</table>
Analysis of Coping Strategies

Because donor use of other potential coping strategies were not controlled in the present study, all donors were asked to report on their use of fluids, distraction strategies while donating, or “other” coping strategies. Table 8 lists the percentages of participants in each group who reported various beverages consumed (e.g., soft drinks, juice), distractions (e.g., listening to music, reading, talking), or other coping strategies (e.g., talking, deep breaths). Results of chi-square analyses comparing the proportion of these activities in each group revealed that no significant differences were found between groups for the use of fluids, $X^2(1, N = 82) = 3.32, p = .07$, distraction, $X^2(1, N = 82) = 2.31, p = .13$, or other coping strategies, $X^2(1, N = 81) = 0.57, p = .45$.

DISCUSSION

The present study examined the effectiveness of water loading in attenuating subjective physiological reactions to blood donation in novice donors. It was hypothesized that participants given a water loading manipulation (500 ml of bottled water prior to donation) and those who had greater total body water levels would experience fewer reactions to blood donation. Furthermore, it was hypothesized that fluid loaded participants would report fewer phlebotomist interventions and an increased likelihood of donating again.

Group Differences

The hypothesis that water loading would result in fewer subjective physiological reactions to blood donation was supported by the data. In the current sample of 83 young
Table 8

Proportions of Blood Donation Coping Strategies as a Function of Experimental Group (Water, No Water)

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>No Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluid</strong> (e.g., juice, soft drinks)</td>
<td>55.8%</td>
<td>32.5%</td>
</tr>
<tr>
<td><strong>Distraction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Music</td>
<td>9.3%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Talking</td>
<td>9.3%</td>
<td>30.0%</td>
</tr>
<tr>
<td>Reading</td>
<td>14.0%</td>
<td>7.5%</td>
</tr>
<tr>
<td>Other (e.g., counting tiles on floor)</td>
<td>27.9%</td>
<td>42.5%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>60.5%</td>
<td>87.5%</td>
</tr>
<tr>
<td><strong>Other</strong> (e.g., deep breaths)</td>
<td>11.5%</td>
<td>20.0%</td>
</tr>
</tbody>
</table>
adults, statistical analyses revealed that those who received 500 ml of bottled water prior to donating blood for the first time reported significantly lower overall reaction scores to donation than those who did not. Although water loading has not previously been tested as an intervention for use with blood donors, research examining the effects of water on cardiovascular responses to head-up tilt testing has demonstrated that water loading offsets and prevents mild to severe vasovagal reactions (Lu et al., 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002). Specifically, water ingestion has been found to diminish increases in heart rate and decreases in stroke volume, slightly increase blood pressure as a result of increased total peripheral resistance, and improve cerebral blood flow regulation during head-up tilt.

Although specific physiological responses were not measured in the present study, it can be speculated from previous research on water loading that negative reactions were attenuated by increased blood pressure, thus increased cerebral perfusion. Jordan and colleagues (2000) studied the mechanisms that could potentially increase blood pressure with water drinking, including hematocrit, plasma catecholamines (i.e., norepinephrine), vasopressin, and plasma renin activity. Indeed, blood pressure increased after drinking water. However, plasma norepinephrine was the only cardiovascular mechanism that responded to water consumption, increasing 30 minutes after drinking occurred. Plasma renin activity, vasopressin, and plasma volume were not affected by water consumption. Since norepinephrine is a vasoconstrictor, increased plasma norepinephrine levels result in increased blood pressure, thus increasing blood flow to the brain.
The vast majority of the literature examining water loading has explored the acute cardiovascular effects of water ingestion (Lu et al., 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, & Hainsworth, 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002; VanderKaay et al., in press), as opposed to long-term increased hydration. One study examining long-term fluid hydration status indicated that increased hydration is related to decreased cardiovascular reactivity during passive physical challenge (i.e., posture change; Patterson et al., 2001). To examine fluid hydration status effects in the context of blood donation, pre-donation total body water was measured in the present study to investigate the effects of hydration status on reports of negative reactions to blood donation.

The hypothesis that greater total body water would result in fewer negative physiological reactions was not supported by the data. There are a couple of possible explanations for this finding. First, as previously mentioned, water ingestion has an acute pressor effect that is sustained for slightly greater than 60 minutes (Jordan et al., 2000). Therefore, it is possible that this acute pressor response is needed in order to observe cardiovascular changes that prevent vasovagal reactions, and chronic hydration status may not elicit the necessary cardiovascular adaptations. In fact, lower resting blood pressure has been observed in chronically hydrated individuals (Patterson, France, Prause, & Gill, 2002; Patterson & Spinks, 2002). Therefore, since low blood pressure is predictive of reactions (Kasprisin et al., 1992; Ogata et al., 1980), chronic hydration might actually increase reaction rates. Compared to total body water estimates from the third National Health and Nutrition Examination Survey (NHANES-III; Chumlea et al.,
2002), the individuals in the present study were normally hydrated. Specifically, total body water estimates for individuals similar to those in this study (the majority being non-Hispanic white with the average age of 19) are 43.2 liters for males and 31.9 for females, whereas the average hydration status for the males and females in this study were 44.7 and 30.6 liters respectively.

Second, although research on hydration status has demonstrated beneficial cardiovascular changes in response to physical challenge, it has also shown that hydration status is unrelated to cardiovascular reactivity during passive psychological stress (Patterson et al., 2001). In other words, those with greater total body water had fewer reactions to standing, but no relationship was observed between total body water and reactions to a psychologically stressful surgery video. Yet, the literature on blood donation reactions states that donors have negative reactions for both psychological (Labus et al., 2000; Meade et al., 1996) and physical (Graham, 1961; Kasprisin et al.; Trouern-Trend et al., 1999; Ogata et al.) reasons. According to this evidence, it is possible that total body water did not affect reports of negative reactions in the present study because psychological stressors (e.g., fear and anxiety around blood and needles) were more significant to these donors than physical stressors (e.g., loss of blood, standing). Information on specific predictors of reactions, however, was not obtained.

Despite the fact that water loading was effective in attenuating negative blood donation reactions, the hypothesis that pre-donation water loading would interact with pre-donation total body water and result in fewer donor reactions was not supported by the data. Once again, the acute pressor response to water ingestion may be necessary in
order to offset the drop in blood pressure following blood donation that often leads to subjective physiological reactions.

*Phlebotomist Interventions*

Previous research has demonstrated that donors who report fewer and less severe reactions will often also report fewer phlebotomist interventions (Bonk et al., 2001; Ditto et al., 2003; Meade et al., 1996). In the present study, despite fewer reported reactions, those in the water group did not report differential levels of phlebotomist interventions. Yet the effect was in the correct direction, with the water group reporting a lower percentage of phlebotomist interventions. There are a number of potential reasons as to why both groups reported similar phlebotomist interventions, despite significantly lower Blood Donation Reactions Inventory scores in the water group. First, it is possible that no difference was found between the groups because, as a precautionary measure, the phlebotomists were quick to intervene, reclining chairs preventatively for many of the donors regardless of whether or not reactions were present, thus decreasing their chances of reactions. As previously illustrated in Figure 5, the proportion of phlebotomist interventions in the present study was low. Therefore, phlebotomists may have been reticent to intervene in the case of mild reactions. Since only a fraction of donors experience severe reactions (e.g., loss of consciousness) and the majority of donors experience milder reactions such as lightheadedness and dizziness (Kaloupek & Stoupakis, 1985; Ogata et al., 1980; Trouern-Trend et al., 1999), there may not have been enough donors from the sample that experienced severe reactions to detect a difference. In fact, only 1 out of 83 participants (1.2%) in the present study reported a loss of
consciousness. The participant that fainted belonged to the water group.

*Intention of Future Donation*

The theory of reasoned action states that behavior is best predicted by the intentions to do the behavior (Schifter & Ajzen, 1985). Therefore, donors in the present study were asked to report their intentions of donating again. Prior research has demonstrated that donors who experience fewer negative donation reactions report greater intention of donating blood in the future (Bonk et al., 2001; Ditto et al., 2003; Meade et al., 1996; Piliavin, 1990). In the present study, however, the hypothesis predicting that the water group would report an increased intention of future donation was not supported. Both groups (water, no water) reported similar intentions of future blood donation. Interestingly, Blood Donation Reactions Inventory scores were negatively correlated with intentions of future donation ($r = -.53, p< .01$), so that ratings of intentions to donate again in the future were lower in those who reported more negative reactions to donation. According to the attribution theory (Lewis & Daltroy, 1990), individuals may attribute negative experiences to situational or external factors (e.g., inexperienced phlebotomist) rather than dispositional or internal factors (e.g., fear of blood). Therefore, it can be speculated that donors who reported reactions attributed their negative experiences to external factors, and therefore do not expect to have the same negative experiences with future donations. Another possibility for no group difference of intentions may be influenced by factors other than negative donor experiences (e.g., large time commitment). Thus, reporting lower ratings of intentions to give blood again may not be related to intervention effectiveness in terms of reactions.
Finally, likelihood reports in this donor sample were very high (water group, M = 76.8, SD = 27.5; no water group, M = 72.9, SD = 28.3). Statistically, there may have been a ceiling effect with such high reports, making it difficult to detect significant differences in reports. This finding is consistent with prior studies using this measure that have also observed high reports (Bonk et al.; Ditto et al.; Meade et al.), despite the fact that most first-time donors do not donate again within a one-year period (Piliavin). Thus, this item is likely influenced by social desirability demands such that donors tend to exaggerate their true intentions.

Social psychology literature on social prediction indicates that individuals make more accurate predictions of others’ performance/behavior than their own (Dunning, Griffin, Milojkovic, & Ross, 1990), perhaps because they are less influenced by social desirability. Therefore, participants in the present study were also asked to report their predictions of the intentions of other donors in the study to donate blood in the future. Consistent with the previous finding, the data did not support the hypothesis predicting that those in the water group would report an increased likelihood that other participants in the study would donate again in the future. Similar to the self likelihood reports, reports for the intentions of others were also very high (Water group, M = 66.8, SD = 19.5; No water group, M = 68.8, SD = 20.4).

**Limitations**

Several issues relevant to the validity of the present findings may limit their generalizability. First, due to a relatively high deferral rate (men = 3, women = 9) for health reasons (e.g. acute illness, low iron) and the nature in which participants assigned
themselves to the treatment conditions, a sex imbalance within groups occurred (water 
group, males = 29, females = 14; no water group, males = 14, females = 26). Trouern-
Trend and colleagues (1999) found that, overall, women have more adverse reactions to 
blood donation than men. According to this finding, it may be possible that the water 
group in the present study reported fewer negative reactions due to a greater number of 
males in that condition. However, the water loading intervention was effective in both 
men and women, with men and women for each group having similar reactions scores. 
Since the present study found no group differences in body mass index or body weight, it 
is clear that this was not a limitation because the groups did not differ in terms of blood 
volume. Most often, research regarding sex as a predictor of negative blood donation 
reactions has found that sex has no effect on donor reactions (Graham, 1961; Kasprisin et 
al., 1992; Moloney et al., 1946; Ogata et al., 1980; Poles & Boycott, 1942).

Another possible limitation of the present study pertains to the use of a no water 
control group. Whereas a true control condition would imply that both the experimental 
and the control group have the same experience, in the present study the control group 
did not experience the drinking manipulation at all. The implication is that the water 
group experienced a treatment effect whereas the control group did not. A treatment 
effect is the nonspecific psychophysiologic effect brought on by a treatment by way of 
the knowledge or symbolic significance of the treatment or intervention (Papakostas & 
Daras, 2001). In other words, participants that received the water intervention may have 
had specific expectations that reflected their knowledge of the therapeutic agent of the 
intervention and/or the condition and circumstance in which it was used (e.g., blood
donation) that may have triggered a treatment response. Participants in the control group were not experiencing a treatment effect because they did not know that there was another group that received water. In future investigations, a possible solution would be to give the control group a small amount of water (placebo), or to conduct a dose-response study. For instance, in a recent study (Routledge et al., 2002), participants in the control condition received 20 ml of water versus 500 ml in the experimental group.

One difficulty in developing a placebo control or a dose-response study is determining the amount of water used. Is 20 ml of water too much? The amount of water chosen for the present study was used to be consistent with previous laboratory research on water loading effects on cardiovascular reactions (Lu et al., 2002; Routledge et al., 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, & Hainsworth, 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002). At this time, it is unclear how much water is needed to produce a sufficient cardiovascular response. In order to answer this question, a dose-response study could be developed in which participants are given varying amounts of pre-donation water (e.g., 0, 50, 100, 200, 500, 1000 ml). In sum, additional research is required to determine the true benefit of water loading prior to donation.

On a similar note, it is possible that the types of fluid consumed and their various rates of absorption have different effects on cardiovascular mechanisms of the body. Since water and other fluids are absorbed in the proximal small intestine (Leiper, 1998), the rates at which fluids are emptied from the stomach are an important part in determining rates of absorption. Generally, the gastric emptying rate of water is faster
than that of other fluids (Brouns, 1998). In fact, when the concentration of carbohydrate in a fluid rises above 7%, gastric emptying is slower. Gastric emptying time is hardly affected when carbohydrate concentration is below 7%, which is one reason why the recommended carbohydrate concentration in sports drinks is less than 7%. Once fluid is in the intestines, proper osmotic gradients must be produced in order for it to be absorbed (Leiper). Carbohydrates and electrolytes are highly effective in producing osmotic gradients, thus increasing the rate of fluid absorption. Dilute hypotonic glucose-sodium solutions are very effective oral rehydration drinks because they include water, carbohydrates (glucose), and electrolytes (sodium). Water is able to be absorbed in the intestines on its own, but without the addition of carbohydrates and electrolytes it is a relatively passive process. All in all, the absorption rates of rehydration drinks such as Gatorade are much quicker than that of water. It would be interesting to investigate fluids with varying absorption rates to determine if the rate of absorption affects the cardiovascular benefits of fluid loading.

In contrast with the suggested user instructions for the bio-electrical impedance monitors, the current study did not instruct participants to abstain from eating and drinking for 4 hours prior to testing. This may be a limitation because participants entered the study at varying states. The rationale behind this guideline is that having participants fast will control for any short-term dietary or postprandial effects on hematological or hemodynamic variables (Lipsitz, Nyquist, Wei, & Rowe, 1983; Robertson et al., 1978). However, due to ethical reasons (e.g., unsafe for donors not to eat and drink before blood donation), the present study did not adhere to this guideline.
This may have influenced the data given that blood pressure decreases following a meal (Lipsitz et al.) and caffeine increases plasma renin activity, plasma norepinephrine, and plasma epinephrine (Robertson et al.), thus increasing blood pressure. In addition, total body water may have been slightly greater in some individuals as a result of eating and drinking, but not enough to notice a difference.

In addition to suggesting that the participants abstain from eating and drinking for 4 hours prior to testing, the user instructions for the bio-electrical impedance monitors also state that participants must lay supine for at least 10 minutes prior to assessment. According to the instructions, it takes at least 10 minutes for body water levels to fully equalize throughout the body. However, participants in the present study laid supine for only 5 minutes. Therefore, the body water measurements may not have been accurate because participants’ body water levels were not yet completely balanced.

Another area of the methodology that presents with limitations is related to the pre-donation blood pressure measurements. The first problem is that all of the blood pressure data analyzed and reported in this study related to a single blood pressure measurement taken prior to the body water assessment. This may be problematic because multiple blood pressure measurements may be required to arrive at an accurate measurement of true resting blood pressure. Furthermore, although there was a 5-minute resting period prior to this blood pressure measurement, participants may have had increased blood pressure due to the anticipation of donating blood for the first time. Thus, it may have been more reflective of participants’ actual resting blood pressure to obtain and analyze more than one blood pressure measurement.
The other problem regarding the pre-donation blood pressure measurements concerns the three “filler” blood pressure measurements taken between the body water assessment and blood donation (when the water group consumed water). Since these measurements were taken in order justify the 10-minute waiting period in which the water group consumed water, and the data was not going to be used for the goals of the study, the measurements were not recorded. In retrospect, however, it would have been beneficial to have access to this data. In fact, access to this data would have corrected the preceding limitation, possibly offering a more accurate resting blood pressure measurement.

Lastly, since research has demonstrated that negative reactions to blood donation can be attenuated by donor coping strategies such as distraction (Bonk et al., 2001) and caffeine (Sauer & France, 1999), donors in the present study were asked to report on their use of fluids, distraction strategies while donating, and “other” coping strategies. Although the groups did not differ significantly for any of the coping strategies, it was noted that 55.8% of the water group reported using fluids compared to 32.5% of no water group. There are several possible explanations for this difference in fluids. It is possible that this percentage was elevated because it was not clear to the water group whether or not they should also report the water that they consumed for the study. The use of diet diaries may have been a better method of collecting this data regarding the use of fluids. Second, the intervention itself may have alerted these participants to the importance of pre-donation fluid consumption and therefore they may have been more likely to consume additional water while waiting to donate.
Implications and Future Directions

The present study adds to the existing literature on interventions for blood donation reactions, demonstrating that pre-donation water loading is effective in attenuating blood donation reactions in novice donors. Interestingly, this study also found that pre-donation total body water level did not predict reactions, suggesting that being well hydrated may not be enough to attenuate donor reactions. Therefore, the acute cardiovascular responses that result from water loading (e.g., diminished increase in heart rate, maintained blood pressure, increased cerebral blood flow; Lu et al., 2002; Routledge et al., 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, & Hainsworth, 2002; Schroeder Bush, Norcliffe, Luft, Tank, Jordan, Hainsworth, & Volhard, 2002) may be necessary in order to offset the physiological changes that occur during blood donation.

Although the findings of the present study are encouraging, future examinations are required to further assess their generalizability, as well as possible mechanisms of action. The participants of this study consisted of predominantly young college students donating for the first-time. Novice donors were chosen because they are an ideal population for testing potential reaction-reducing interventions, since first-time donors experience significantly more reactions than repeat donors (Callahan et al., 1963; Kasprisin et al., 1992; Trouern-Trend et al., 1999; Ogata et al., 1980; Williams, 1942). Overall, further research is needed to test the generalizability of pre-donation water loading on a more diverse population of donors. Future research should also investigate a possible dose effect for fluid loading, using various types of fluids. Thus far, it is unknown whether or not varying the type of fluid or altering the amount of fluid would
further lessen or increase the negative physiological reactions that can occur during blood donation. To examine the aforementioned questions, a logical next step may be to investigate the cardiovascular (i.e., blood pressure, heart rate) effects of water loading in blood donors. Since the amount and type of fluid needed to produce beneficial effects is unclear, an examination of cardiovascular responses at varying types and doses of fluid would be valuable. It would also be advantageous to explore the timing of pre-donation water loading to answer the question of whether there is a specific period of time prior to blood donation when the cardiovascular effects of fluid loading are most effective.

Conclusion

Drinking 500 ml of water prior to blood donation was found to be effective in preventing negative subjective physiological reactions in first-time blood donors. Although the mechanism of this effect remains speculative, the acute cardiovascular changes that result from pre-donation water loading may be beneficial in counteracting the decrease in blood pressure that often occurs during blood donation. These findings suggest a simple and cost-effective strategy that can enhance the donation experience, and possibly increase donor retention.
REFERENCES


National Blood Data Research Center (2003). 


Appendix A

Preliminary Screening Form

Name:______________________________________________.

Current Phone Number: (______) _______ - _________.

This study is looking for people who:

- Have never donated blood before.
- Have no major health problems.
- Are not taking any medications (this does not include birth control pills).
- Have not received a tattoo or piercing in the past year.
- Are not pregnant.

This study will involve:

- One short informational/consent meeting. (WORTH **ONE** EXPERIMENT POINT)
- Donating blood at a local American Red Cross blood drive during the upcoming quarter. (WORTH **THREE** EXPERIMENT POINTS)

I AM WILLING TO PARTICIPATE IN THIS STUDY.

[ ] YES

[ ] NO
Appendix B

Information Session Screening Form

Directions: Everyone in attendance will get one point at the end of the session. Only those who meet the following eligibility requirements can participate in the blood donation study (which is worth 3 more points):

To participate in the blood donation study, you must:
- Have never donated blood before,
- Have no major health problems,
- Not be taking any medications (although birth control medication is allowed),
- Not have received a tattoo in the past year,
- Not have had a body piercing in the past year,
- Not be pregnant.

If you meet these eligibility criteria, please pay close attention for additional directions regarding the blood donation study…
Appendix C

**Human Subjects Informed Consent Form (Control)**

Title of Research: **Exploring the Relationship Between Body Water and the Blood Donation Experience**

Principal Investigator: **Sarah Hanson**  
Advisor: **Christopher France, Ph.D.**  
Department: **Psychology**

Federal and university regulations require signed consent for participation in research involving human subjects. After reading the statements below, please indicate your consent by signing this form.

**Explanation of Study**  
**Aim**—The purpose of this study is to explore the relationship between body water and the blood donation experience for first time donors, with the overall goal of enhancing donor retention.  
**Procedure**—At scheduled times, 60 minutes before donation, all participants will arrive at the laboratory. Basic demographic information and baseline cardiovascular measures (e.g., blood pressure) will be obtained at this time with the use of an automated blood pressure monitor and a bioelectrical impedance monitor. Bioelectrical impedance analysis measures the resistance and conductance of a weak electrical current that is passed through the body. Resistance is measured across adhesive surface electrodes placed on the right knee and throat area. Individual testing may last from ten to fifteen minutes. You will then be instructed to proceed to the donation site. On completion of donation, you will be instructed to return to the lab. You will then be asked to complete a questionnaire.  
**Duration of participation**—The entire experience (pre-donation, donation, and post-donation) will take approximately 3-4 hours.

**Risks and Discomforts**  
The risks posed by this study are no greater than those typically associated with blood donation. Most people feel fine during and after blood donation. A few people may experience an upset stomach, slight dizziness, or tenderness at the donation site. In some cases, an individual may faint. Phlebotomists are trained to treat these difficulties should they occur. Participation is voluntary and you may withdraw from the study at any time without penalty.

**Benefits**  
The primary goal of the study is to explore the relationship between body water and the blood donation experience for first time donors. This research may enhance retention of first-time donors due to greater satisfaction with the donation experience.
**Confidentiality and Records**
Efforts to maintain the confidentiality of participant information include 1) ensuring that no data identifying individual participants will be released to persons other than the Primary Investigator and the Advisor and 2) recording all study information anonymously, using only a participant ID code.

**Compensation**
Participants will be awarded research participation credits (one credit for the informational meeting and three credits on the day of donation).

**Contact Information**
If you have any questions regarding this study, please contact:
  
  **Christopher France, Ph.D.**
  740-593-1079
  France@ohio.edu

If you have any questions regarding your rights as a research participant, please contact Jo Ellen Sherow, Director of Research Compliance, Ohio University, (740)593-0664.

I certify that I have read and understand this consent form and agree to participate as a subject in the research described. I agree that known risks to me have been explained to my satisfaction and I understand that no compensation is available from Ohio University and its employees for any injury resulting from my participation in this research. I certify that I am 18 years of age or older. My participation in this research is given voluntarily. I understand that I may discontinue participation at any time without penalty or loss of any benefits to which I may otherwise be entitled. I certify that I have been given a copy of this consent form to take with me.

Signature_________________________________________ Date__________________

Printed Name_________________________________________
**Human Subjects Informed Consent Form (Experimental)**

Title of Research: **Exploring the Relationship Between Body Water and the Blood Donation Experience**

Principal Investigator: **Sarah Hanson**
Advisor: **Christopher France, Ph.D.**
Department: **Psychology**

Federal and university regulations require signed consent for participation in research involving human subjects. After reading the statements below, please indicate your consent by signing this form.

**Explanation of Study**

**Aim**—The purpose of this study is to explore the relationship between body water and the blood donation experience for first-time donors, with the overall goal of enhancing donor retention.

**Procedure**—At scheduled times, 60 minutes before donation, all participants will arrive at the laboratory. Basic demographic information and baseline cardiovascular measures (e.g., blood pressure) will be obtained at this time with the use of an automated blood pressure monitor and a bioelectrical impedance monitor. Bioelectrical impedance analysis measures the resistance and conductance of a weak electrical current that is passed through the body. Resistance is measured across adhesive surface electrodes placed on the right knee and throat area. Individual testing may last from ten to fifteen minutes. You will then be given 10 minutes to drink two bottles of water before proceeding to the donation site. On completion of donation, you will be instructed to return to the lab. You will then be asked to complete a questionnaire.

**Duration of participation**—The entire experience (pre-donation, donation, and post-donation) will take approximately 3-4 hours.

**Risks and Discomforts**

The risks posed by this study are no greater than those typically associated with blood donation. Most people feel fine during and after blood donation. A few people may experience an upset stomach, slight dizziness, or tenderness at the donation site. In some cases, an individual may faint. Phlebotomists are trained to treat these difficulties should they occur. Participation is voluntary and you may withdraw from the study at any time without penalty.

**Benefits**

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Signature_________________________________________ Date__________________

Printed Name__________________________________________
Appendix D

Data Record

Arrival Time: ________________

Do you have any major health problems?  YES  NO

Are you currently taking any prescription medications?  YES  NO

What have you had to eat and drink today?  (Include amounts) __________________
_____________________________________________________________________
_____________________________________________________________________  

Gender:   M      F

Age: _______

Height: _______ in. x 2.54 = _______ cm

Weight: _______ lb. x .454 = _______ kg

Heart Rate: _______ bpm

Blood Pressure:

   Systolic: _______ mmHg

   Diastolic: _______ mmHg

Water remaining (if applicable) : _______ ml

To be filled out later:

Impedance Value:

   TBW: _______  EBW: _______  IBW: _______
Appendix E

Blood Donation Reactions Inventory

Directions: Indicate the degree to which you experienced the following sensations at the blood donation clinic today by circling a number between 0 ("not at all") and 5 ("to an extreme degree").

0 = not at all  
1 = to a slight degree  
2 = to a moderate degree  
3 = to a strong degree  
4 = to a very strong degree  
5 = to an extreme degree

<table>
<thead>
<tr>
<th>1. Faintness (as if about to faint or become unconscious)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Dizziness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. Weakness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. Facial flush</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. Visual disturbance (such as blurred vision or tunnel vision)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. Difficulty hearing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Lightheadedness</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. Rapid or pounding heartbeat</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. Sweating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. Rapid or difficult breathing</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. Nausea or upset stomach</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

12. At the clinic today, did you faint ("black-out" or lose consciousness)?  Yes / No

13. At the clinic today, did anyone...
   a) recline your donation chair (raise legs at or above heart level)?  Yes / No
   b) help you get from your donation chair to a recovery area?  Yes / No
   c) have you breathe into a paper bag?  Yes / No
d) have you put your head between your knees?  Yes / No  
e) apply a cold compress to your forehead or neck?  Yes / No  
f) have you loosen any tight or restrictive clothing?  Yes / No  
g) instruct you to take a deep breath and then cough?  Yes / No  
h) give you any form of first aid?  Yes / No  
i) remove your donation needle because you lost consciousness? Yes / No  

14. In the next year…  
  a) how likely are you to donate blood again (give a rating from 0 to 100%)?   
______%  
  b) how likely are others who participated in this study to donate blood again?  
______%
Appendix F

**Blood Donation Coping Strategies**

15. Did you have anything to drink while you were waiting to donate blood today?  
   Yes / No

   If yes, please describe the type of drinks and approximate amounts of each:

<table>
<thead>
<tr>
<th>Drink Type</th>
<th>Amount (in ounces)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

16. Did you do anything to distract yourself during your blood donation today?  
   Yes / No

   If yes, please list the things that you did to distract yourself

<table>
<thead>
<tr>
<th>Distraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

17. Did you do anything else to help you cope with your blood donation today?  
   Yes/No

   If yes, please describe:

   ______________________________________________________
   ______________________________________________________
   ______________________________________________________
Appendix G

Debriefing Form

Title of Research Proposal: Fluid Loading to Attenuate Subjective Physiological Reactions in First-Time Blood Donors.

Primary Investigator: Sarah Hanson, Ohio University

Thank you for participating in this study!

The objective of this study was to reduce subjective physiological reactions (e.g., faintness, dizziness, lightheadedness, nausea) to blood donation in first-time blood donors, with the ultimate goal of increasing donor retention. To accomplish this, half of the participants were instructed to drink 500ml of water pre-donation. (Approximately 500ml of blood is drawn during blood donation.) This intervention is called fluid loading. Previous research has demonstrated that fluid loading has been found to prohibit drops in blood pressure that lead to negative reactions such as fainting. The present study hypothesized that body water is related to the blood donation experience. Specifically, lower body water will result in a greater likelihood that a donor will experience subjective physiological reactions. Therefore, pre-donation fluid loading was used to lessen these reactions.

If you have any questions regarding this study, please feel free to contact Dr. Christopher France at (740)593-1079.