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## Donor anxiety, needle pain, and syncopal reactions combine to determine retention: A path analysis of two-year donor return data

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### Abstract

**BACKGROUND**—Efforts to expand the donor pool by recruiting younger donors have resulted in higher numbers of initial donations, but retention of young donors continues to be a problem.

**STUDY DESIGN AND METHODS**—Path analysis was used to examine the simultaneous relationships among syncopal reactions, donation anxiety, needle pain, donor satisfaction, and donation intention in the prediction of repeat donation. Participants included 421 first- and second-time donors recruited for a study comparing the effects of pre-donation water loading with and without the use of applied muscle tension during donation (52% female, 60.8% first-time donor, mean age 20.3 years). For this longitudinal follow-up study, donor database records were accessed two years after the index donation to determine whether a repeat donation had been attempted.

**RESULTS**—Results of a series of path analyses demonstrated the influential role of donor anxiety in shaping donor retention (final model  $\chi^2=35.75$ , RMSEA=0.03, CFI=0.98, WRMR=0.74). First, anxiety exerted a direct negative influence on donation intention, the proximal and sole direct predictor of repeat donation. Second, anxiety increased the likelihood of donor-reported needle pain, adversely affecting donation satisfaction and, subsequently, donation intention. Finally, anxiety was associated with donor ratings of syncopal reactions through its impact on needle pain, which also contributed to decreased donation intention.

**CONCLUSION**—These results provide novel evidence that donation anxiety plays a central role in shaping future donation behavior; hence, individual differences in anxiety must be considered when developing and testing strategies to enhance blood donor retention.

### Keywords

Blood donor; syncopal reactions; anxiety; pain; donor satisfaction

### INTRODUCTION

Recent efforts to expand the donor pool by recruiting younger donors have resulted in higher numbers of initial donations;<sup>1</sup> however, retention of young donors has been a significant problem. The majority of these donors do not return to provide a repeat donation, and only a

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small proportion goes on to become committed blood donors.<sup>2-4</sup> As a result, the current blood supply is highly reliant on first-time donors,<sup>5</sup> but these new donors must constantly be replaced because they typically fail to return.

Although a number of factors shape individual decisions to donate, both retrospective and prospective studies demonstrate that the experience of syncopal reactions (i.e., full faint as well as presyncopal symptoms such as faintness, dizziness, and lightheadedness that can progress to a full faint) is a particularly important barrier to blood donor retention.<sup>6-17</sup> For example, in a one-year prospective study of nearly 90,000 blood donors, we demonstrated a return rate of 64% for those who did not react versus 40% for those who did.<sup>18</sup> We later confirmed this effect in a new sample of nearly 45,000 male donors — non-reactors returned at a rate of 67.3% as compared to 42.1% for reactors.<sup>15</sup> Not surprisingly, in both of our studies the return rate was lowest for those who reacted while donating for the first time. Similar deterrent effects have been reported by other investigators, with minor reactions leading to 14–23% reductions in return rates the following year and major reactions leading to 25–49% losses.<sup>4,17,19</sup>

In an effort to reduce the likelihood of syncopal reactions, and thereby increase donor willingness to return, a number of approaches have been proposed including applied muscle tension, pre-donation hydration, and distraction. Each of these approaches has been supported by randomized controlled trials that have demonstrated significant reductions in syncopal reactions, albeit with varying outcomes across studies and donor groups.<sup>20-27</sup> Further, recent large-scale observational studies have reported significant reductions in syncopal reactions following implementation of a combination of screening for estimated blood volume and application of muscle tension and pre-donation hydration interventions.<sup>28,29</sup>

Despite the apparent success that the various interventions have had on attenuating syncopal reactions, few studies have examined the extent to which this effect translates into enhanced donor retention. In one exception, Ditto and colleagues<sup>30</sup> demonstrated an enhanced likelihood of return within two years among women, but not men, who had been taught to use applied muscle tension during blood donation as compared to a no-treatment control condition. Interestingly, a reduction in reported syncopal symptoms during the index donation did not account for the subsequent return behavior, suggesting that the other non-physiological mechanisms may have been responsible for the effect of the intervention on return behavior. These findings indicate that additional effort is required to look at the relationship between interventions designed to reduce syncopal reactions, donor return behavior, and potential variables that may help to explain the relationship between intervention and retention.

In line with this goal, the present report analyzes two-year donor return behavior among novice blood donors who engaged in pre-donation water consumption with and without leg muscle activation during donation as compared to those assigned to a control condition. Initial findings from this randomized controlled trial demonstrated that the interventions produced significant reductions in presyncopal reactions, as indexed by both donor self-report and phlebotomist ratings.<sup>24</sup> In the present report we use path analysis to examine the complex simultaneous relationships among syncopal reactions, donation anxiety, needle pain, donor satisfaction, and donation intention in the prediction of donor return behavior.

## MATERIALS AND METHODS

### Participants

Participants were originally recruited for an intervention study examining the effect of pre-donation hydration and applied muscle tension on presyncopal reactions in response to blood donation.<sup>24</sup> At that time, participants gave their consent to be tracked by their donor number for subsequent blood donation attempts in the next two years.

All participants were donors at American Red Cross blood collection sites in central and southeast Ohio, with the majority of the testing sites located on college campuses. Donors who met the original study's inclusion criteria (i.e., first- or second-time blood donor, eligible to donate, at least 18 years of age) were invited to participate. The final sample for these analyses included 421 adults (219 women, 202 men) with a mean age of 20.3 years (SD = 5.2); 60.8% were first-time donors and 39.2% were donating blood for the second time. The majority of participants in the sample self-identified as Caucasian (76.5%). Demographic variables as well as the other measures included in the path analysis are summarized in Table 1. There were no significant differences between first- and second-time donors on any of the demographic variables.

### Materials

**Demographic Survey**—Participants provided a range of personal data including their gender, history of previous donations, and race/ethnicity.

**State Anxiety Inventory**—Anxiety related to the impending blood donation was assessed using a version of the State Anxiety Inventory (STAI-Y),<sup>31</sup> a 20-item scale designed to allow for self-report of state anxiety levels with total scores ranging from 20 to 80. An example item, rated from 1 (not at all) to 4 (very much), is “I am tense.” In the present study this measure had excellent internal consistency (Cronbach's  $\alpha = 0.91$ ), which is consistent with psychometric data from previous blood donation studies.<sup>32–34</sup>

**Blood Donation Reactions Inventory-4**—The Blood Donation Reactions Inventory-4 asks the donor to provide subjective ratings of four syncopal symptoms associated with blood donation on a 0 (not at all) to 5 (to an extreme degree) scale, with total scores ranging from 0 to 20.<sup>35</sup> The four items include 1) faintness, 2) dizziness, 3) weakness, and 4) lightheadedness. Previous research supports the reliability and validity of this measure,<sup>35</sup> and in the present study the internal consistency reliability was high (Cronbach's  $\alpha = 0.94$ ).

**Additional Post-Donation Items**—Donors also completed individual post-donation measures of pain during insertion of the donation needle (range 0=not at all painful to 5=extremely painful), overall satisfaction with the donation experience (rated from 0%=not at all satisfied to 100%=completely satisfied), and estimated likelihood of providing another donation in the following year (rated from 0% to 100% likely).

**Donor Database Records**—To provide a more objective measure of syncopal symptoms, phlebotomist classifications of donor reactions<sup>36</sup> were obtained from the donor record. In addition, these records were consulted to determine whether each participant made a subsequent donation attempt during the two year period following enrollment in the study (i.e., both deferrals and successful donations were counted as a repeat donation).

### Study Design

Participants included donors who were recruited for an intervention study comparing the effects of pre-donation water loading with and without the use of applied muscle tension

techniques during donation (see <sup>24</sup> for a more complete description). Briefly, eligible participants completed informed consent procedures and were randomly assigned to one of four groups, including two control conditions (standard donation or placebo control) and two treatment conditions (pre-donation water or pre-donation water combined with leg exercise). Next, participants were given an anonymous identification code, provided study directions specific to their group assignment, and completed the pre-donation questionnaires (demographics and anxiety). All participants donated according to standard American Red Cross procedures and their group assignment, and then proceeded to a post-donation canteen area where they completed post-donation measures. American Red Cross donor database records were subsequently consulted to obtain information on donor reactions during the index donation.

For this follow-up study examining factors relating to repeat donation behavior, donor database records were accessed again for each of the original participants two years after the index donation in order to determine whether a repeat donation had been attempted in the intervening period.

The study protocol was approved by the Institutional Review Boards of Ohio University and the American Red Cross, and was pre-registered with [www.clinicaltrials.gov](http://www.clinicaltrials.gov) (#NCT00302900).

### Statistical analysis

Structural equation modeling was conducted with Mplus Version 6.12 computer software. Chi-square difference tests were used to compare models. In a step-wise fashion non-significant paths were removed from the model and individual paths suggested by high modification indices were added, and at each step the model was evaluated to see whether fit was improved. Because the main variable of interest, repeat donation, is a binary variable, the models were estimated with a weighed least square parameter estimates. A number of goodness-of-fit indices were examined for each of the models tested. The chi-square statistic provides a test of the null hypothesis that the covariance matrix conforms to the particular model being tested. Since the goal is to develop a model that fits the data, a non-significant chi-square value is desirable. Because the chi-square statistic is dependent on sample size, however, even trivial differences can lead to a significant chi-square result in large samples. Therefore, in structural equation modeling, the pattern of results across a number of goodness-of-fit tests is considered to assess how well a model fits the data. As recommended in the literature, a test from each category of fit indices (comparative fit, parsimony correction, and absolute fit) was included: comparative fit index (CFI) ranges from 0.00–1.00, with values >0.95 considered acceptable; root mean square error of approximation (RMSEA) has a lower limit of 0.00, with values <0.06 considered acceptable; and weighted root mean square residual (WRMR) ranges from 0.00 to infinity, with values <0.90 considered acceptable.<sup>37</sup>

## RESULTS

To account for the interventions that were part of the clinical trial, the sample was divided into treatment and control conditions. Consistent with our original report,<sup>24</sup> Table 1 shows that donors in the treatment condition had fewer syncopal reactions than donors in the control condition (based on both subjective ratings and phlebotomist reports); however, donors in the two conditions did not differ on any of the other characteristics that were measured.

Our initial model was based on the hypothesis that attenuation of syncopal reactions would be associated with increased donor satisfaction, in turn leading to greater intentions to

provide a repeat donation, and ultimately a greater likelihood of donor retention. As illustrated in Figure 1, needle pain and anxiety were expected to have a negative direct influence on donor satisfaction. Finally, prior donation history, donor sex, and treatment group assignment were included in the model based on previous evidence of their association with syncopal reactions.<sup>28,29,38,39</sup> As can be seen in the path analysis results presented in Table 2, the goodness-of-fit tests indicated that this initial model was not a good fit to the data. Therefore, to determine if a good model fit could be achieved, a methodical approach was taken to revise the model paths. First, all non-significant paths from the original model were removed. In addition, because BDRI-4 and phlebotomist ratings both represent the same syncopal reactions from different perspectives, rather than specify a directional path these two variables were allowed to correlate. Next, in a series of sequential steps, modification indices from the path analysis were examined to determine whether additional changes improved the overall model based on the results of chi-square difference tests.

As a result of this sequential process a revised model was specified. As illustrated in Figure 2, the only direct predictor of repeat donation behavior was intention. However, multiple factors had an indirect influence on repeat donation behavior via their impact on intention. Specifically, higher levels of donation intention were reported by women and among those with less anxiety, greater donation satisfaction, and lower subjective syncopal reaction scores. In addition, donors with lower anxiety levels reported less needle pain, which in turn was related to lower subjective syncopal reaction scores. Absence of phlebotomist reports of syncopal symptoms and lower needle pain ratings were also associated with greater donation satisfaction. Finally, previous donation experience was related to lower anxiety, males reported less anxiety and needle pain, and assignment to a treatment condition was associated with attenuation of syncopal reactions relative to controls. As shown in Table 2, this revised model showed a good fit to the data, surpassing standards on all three fit indices (i.e., CFI =0.97, RMSEA=0.04, WRMR=0.83).

Although the revised model was a strong fit to the data, examination of the modification indices suggested that it could be improved by adding a direct path from past donation to intention (see Figure 3). Addition of this pathway yielded a significant chi-square difference test relative to the revised model, and as shown in Table 2 further improved each of the fit indices compared to both of the previous models. Thus the data best supported this final model of return donation behavior.

## DISCUSSION

Based on previous evidence of the importance of donor satisfaction in shaping repeat donation intentions and behavior,<sup>13,40–42</sup> we proposed that satisfaction with the donation process would be a key determinant of intention to provide a repeat donation among novice donors exposed to an intervention designed to reduce syncopal reactions. Further, we posited that donor satisfaction could be negatively influenced by the experience of anxiety, pain, and syncopal symptoms. Notably, given the scarcity of studies examining actual behavior, we ascertained repeat donation attempts by consulting donor database records for a two-year period. Results of a series of path analyses confirmed that donation intention was the sole direct influence on repeat donation behavior. As predicted, satisfaction was a direct predictor of donation intention, and higher levels of needle pain and phlebotomist reports of syncopal reactions were associated with reduced satisfaction. However, our analyses also revealed that anxiety and subjective syncopal reactions exerted a direct effect on donation intention, rather than an indirect effect via satisfaction. Specifically, greater anxiety and higher levels of self-reported syncopal symptoms were associated with a reduced intention

of providing a repeat donation. Finally, those with a previous experience of blood donation reported both lower anxiety and a higher intention of repeat donation.

Many of the interrelationships supported by our path analyses substantiate prior findings in the area of blood donation research. For instance, previous studies have noted the importance of both subjectively and objectively measured syncopal symptoms in the prediction of donor retention.<sup>14,15,18,43</sup> In the present study both donor and phlebotomist ratings of syncopal reactions were retained in the final model, suggesting that the subjective perception of syncopal symptoms accounts for unique variance in predicting donation intentions beyond the influence of syncopal symptoms per se. This result is similar to a previous study in which Blood Donations Reactions Inventory scores remained a significant predictor of donation return behavior even after controlling for donation chair reclining performed by the phlebotomist.<sup>14</sup> Together these findings indicate that individual differences in donors' psychological response to their symptoms may be important in shaping their future donation intentions and behavior (e.g., mild symptoms of faintness or dizziness may appear similar to an external observer, but donors may differ substantially in the extent to which they view their symptoms with alarm or possibly as an indication that they are not well-suited to future donation).

In addition to affirming the importance of syncopal reactions, our data strongly support the influential role of anxiety in the re-donation decision process. First, anxiety exerted a direct negative influence on donation intention. Second, in line with prior pain studies,<sup>44,45</sup> anxiety increased the likelihood of the donor reporting needle pain, which adversely affected donation satisfaction. Finally, the present findings confirm results from numerous studies that higher anxiety levels are associated with increased syncopal reactions among both novice and experienced blood donors,<sup>46-49</sup> and that these anxiety-related reactions may be associated with decreased donor return.<sup>43</sup> While this study did not find an influence of treatment group on anxiety, there is recent evidence that muscle tensing interventions aimed at reducing syncopal reactions are most likely to help donors with elevated levels of anxiety,<sup>27,50</sup> possibly by increasing confidence in their own ability to cope with the donation process. Accordingly, identifying and addressing elevated levels of donor anxiety may be a particularly efficient method of enhancing intentions and repeat donations among novice blood donors. Although we did not measure post-donation anxiety, it is reasonable to speculate that anxiety levels experienced after the completion of the donation process may also exert an independent effect on donation intention. This raises the possibility that interventions that address concerns that may arise after the donation (e.g., bruising, post-donation weakness, delayed syncopal symptoms) could be used to further strengthen donor retention. Consistent with this notion, Sinclair and colleagues<sup>51</sup> demonstrated that a post-donation motivational interview designed to address individual donor concerns was associated with lower anxiety reports and an increased likelihood of repeat donation in the following year.

Although our model emphasizes that anxiety should be an important focus for intervention efforts, it also indicates that there are additional viable targets. For example, physiological interventions that can reduce the risk of syncopal reactions, such as pre-donation hydration<sup>20,21,24,52</sup> or applied muscle tension,<sup>22,30,53,54</sup> should increase donation intention independent of any effect that they may have on donor anxiety. Similarly, efforts to reduce the experience of needle pain (e.g. using an analgesic cream) would be expected to enhance donation satisfaction and donation intention. Finally, creative ways of promoting donation satisfaction may further enhance repeat donation intention among all donors, and may be particularly useful in offsetting the influence of minor discomfort related to needle pain or mild syncopal reactions.



The current study had a number of important strengths, including the use of a longitudinal design with assessment of repeat donation behavior, assessment of both subjective and objective measures of syncopal reactions, and use of path analysis to examine the joint influence of multiple predictors on donation intention and behavior. However, a few limitations are also worth noting. First, the present sample was restricted to relatively novice, college-aged donors and hence the findings may not generalize directly to other donor populations. Second, our effort to model future donation behavior was necessarily limited by the variables which were included in the original intervention study. Because other important predictors of donation intention and behavior have been identified in augmented Theory of Planned Behavior models of blood donation (e.g., self-efficacy, attitude, anticipated regret),<sup>42,55–60</sup> future studies should consider inclusion of these additional predictors to help build potential stronger models.

In sum, the results of the present study provide novel and important evidence that donor anxiety, pain, syncopal reactions, and overall satisfaction each play important roles in shaping future donation behavior. Although additional research is needed to confirm these findings and to identify other potential predictors, the current findings may help guide the development of new strategies to enhance retention of novice blood donors.

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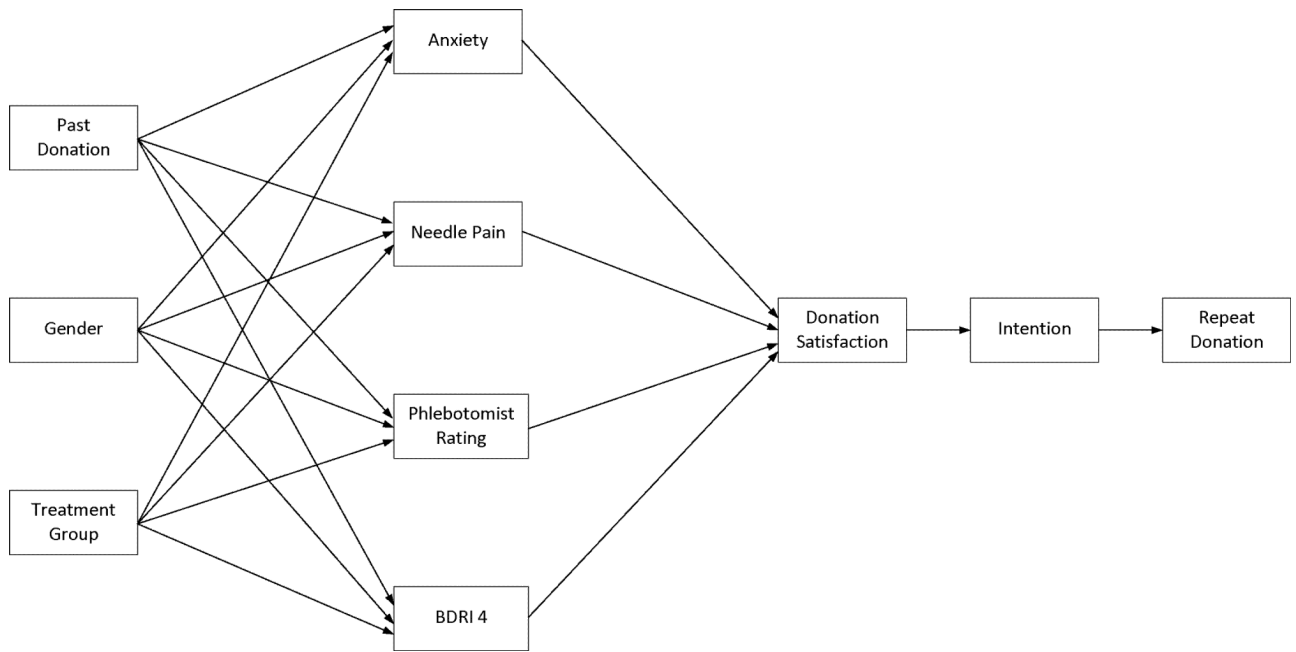
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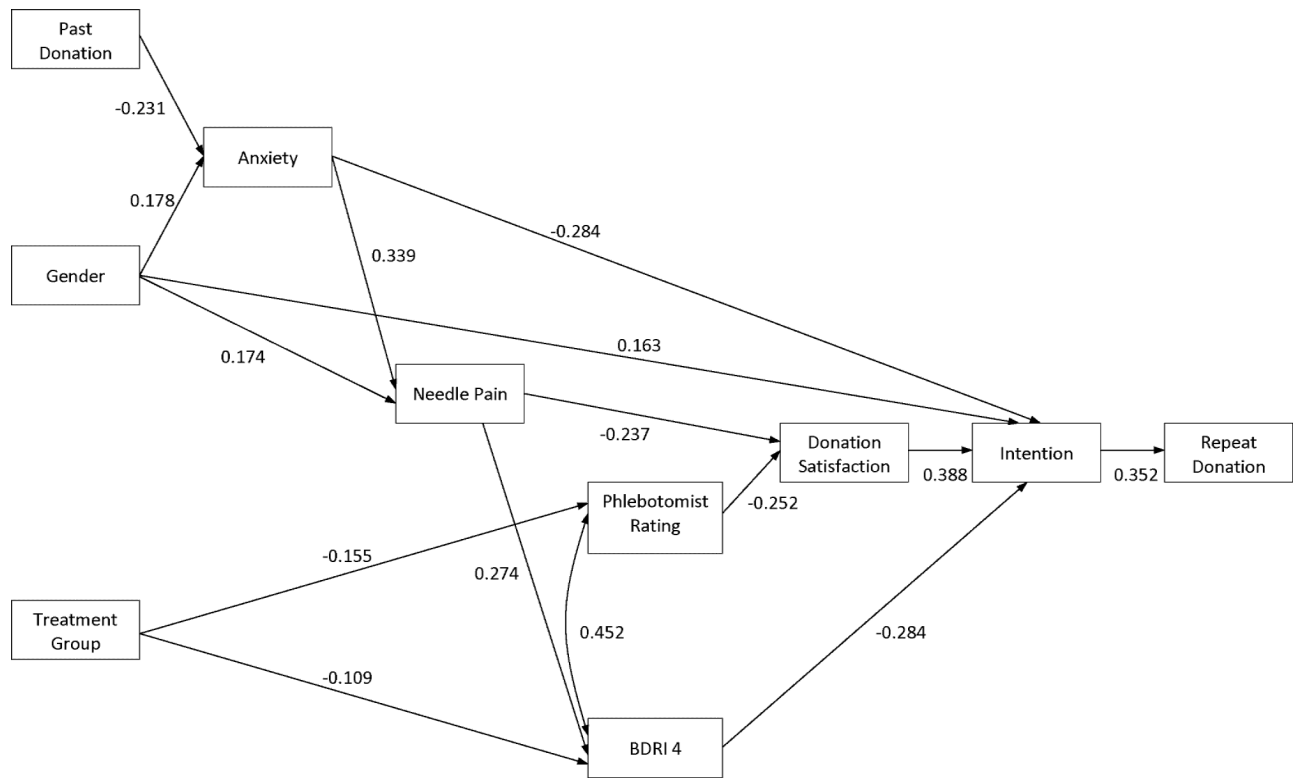


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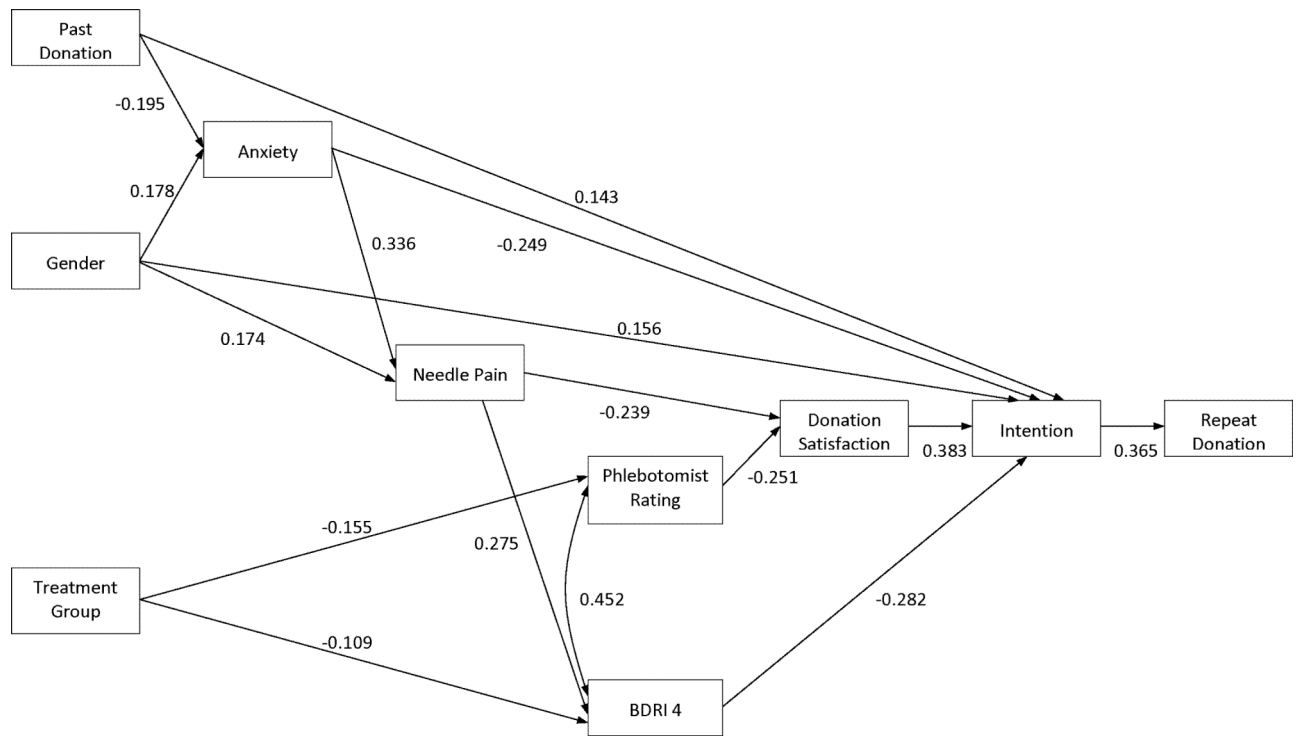
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**Figure 1.**  
Initial hypothesized model of donor return behavior.



**Figure 2.** Revised model of donor return behavior showing standardized path coefficients. For figure simplicity, residual variances for the dependent variables are not indicated.



**Figure 3.** Final model of donor return behavior showing standardized path coefficients. For figure simplicity, residual variances for the dependent variables are not indicated.

**Table 1**

Participant characteristics, expressed as Mean (Standard Deviation) for continuous variables and as N (%) for categorical variables.

Variable	Units	No Treatment (n=209)	Treatment (n=212)
Age	years	20.3 (5.7)	20.3 (4.7)
Female		108 (51.7%)	111 (52.4%)
BMI	kg/m <sup>2</sup>	24.5 (4.5)	24.2 (4.3)
First time donor		133 (63.6%)	123 (58.0%)
Anxiety	score (20–80)	33.1 (8.4)	32.1 (9.3)
BDRI-4*	score (0–20)	4.4 (5.4)	3.2 (4.7)
Phlebotomist rating of reaction*	None	161 (77.0)	187 (88.2)
	Slight (pre-faint)	37 (17.7)	21 (9.9)
	Moderate/Severe (e.g., faint, hematoma)	11 (5.3)	4 (1.9)
Needle Pain	score (0–5)	1.7 (1.1)	1.7 (1.2)
Donation Satisfaction	score (0–100)	92.4 (16.7)	94.4 (12.3)
Repeat Donation Intention	score (0–100)	81.2 (25.4)	83.7 (24.7)
Repeat Donation Attempt		72 (34.4%)	74 (34.9%)

\* p<.05



**Table 2**

Goodness-of-fit test results for the three models.

Model	$\chi^2$ (df), $p^a$	CFI <sup>b</sup>	RMSEA <sup>c</sup>	WRMR <sup>d</sup>
1 (Original)	259.27 (24), <0.001	0.51	0.15	2.11
2 (Revised)	43.38 (27), <0.05	0.97	0.04	0.83
3 (Final)	35.75 (26), 0.10	0.98	0.03	0.74

<sup>a</sup>A non-significant  $\chi^2$  is desirable;<sup>b</sup>Range 0.00–1.00, >0.95 acceptable;<sup>c</sup>Lower limit 0.00, <0.06 acceptable;<sup>d</sup>Range 0.00–infinity, <0.90 acceptable.