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Initial validation of a virtual blood draw exposure paradigm for fear of blood and needles

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ABSTRACT

Fear of blood, injections, and needles commonly prevents or delays individuals' receipt of health care, such as vaccines or blood draws. Innovative methods are needed to overcome these fears and reduce anxiety related to activities of this nature. The present study describes initial testing of an arm illusion paradigm that may prove useful during early phases of graded exposure for people with blood and needle fear. Seventy-four undergraduate students aged 18–29 years were tested. In line with study aims, results indicated that the virtual blood draw paradigm promoted strong perceptions of arm ownership and elicited significant changes in physiological indices (blood pressure, heart rate, electrodermal activity, respiratory rate) in response to key procedure elements (e.g., needle insertion). Further, bivariate correlations indicated that individual differences in self-reported blood and needle fear collected prior to the illusion paradigm were significantly associated with presyncopal symptoms reported following the procedure. In regression analyses, self-reported measures of blood and needle fear explained unique variance in presyncopal symptoms even after controlling for general state anxiety. These findings provide initial support for the virtual blood draw paradigm as a promising tool to help provide graded exposure to medical procedures involving needles and blood draw.

1. Introduction

Needles and blood draws are used in a variety of medical procedures. In this context, fear of blood and needles represents an important individual and public health concern as it is a documented deterrent to procedures such as routine blood work (McAllister, Elshtewi, Badr, Russell, & Lindow, 2012; Wright, Yelland, Heathcote, Ng, & Wright, 2009), insulin injections and finger sticks for diabetes management (Fu, Qiu, & Radican, 2009; Zambanini, Newson, Maisey, & Feher, 1999), dental care (Crego, Carrillo-Díaz, Armfield, & Romero, 2014; Milgrom, Coldwell, Getz, Weinstein, & Ramsay, 1997), vaccinations (Logullo, de Carvalho, Saconi, & Massad, 2008; Taddio et al., 2012; Wright et al., 2009), and blood donation (Wright et al., 2009). A severe form of this fear – termed blood-injection-injury phobia – is characterized by an intense fear of blood, injections, medical care, and injury; such fear is recognized as excessive and unreasonable by the individual (APA, 2013). Blood-injection-injury phobia affects approximately 4% of people in the U.S. However, up to a quarter of the adult population acknowledges experiencing some fear of needles/blood draws (Stinson et al., 2007; Taddio et al., 2012; Wright et al., 2009).

A unique concern associated with fear of blood or needle stimuli (in comparison to other phobias) is that an individual endorsing such fear may be at increased risk for syncopal symptoms (e.g., dizziness, lightheadedness) or syncope (i.e., transient loss of consciousness) following exposure to blood or needles (France, France, Himawan, et al., 2013; Nir, Paz, Sabo, & Potasman, 2003; Wright et al., 2009). The pre/syncopal response is not universal but affects approximately 80% of individuals endorsing such phobia (Ost, Sterner, & Lindahl, 1984; Thyer, Himle, & Curtis, 1985). While the experience of syncopal symptoms is itself considered medically benign, two risks are of note. First, there is an increased risk for physical injury due to falling. Further, the individual may find the symptoms distressing, thus promoting avoidance of future medical or otherwise important procedures (France et al., 2012; France, France, Wissel, et al., 2013; Rader, France, & Carlson, 2007).

Considerable evidence suggests that in vivo exposure is among the most effective interventions for blood-injection-injury phobia, as well as variety of other feared experiences or stimuli (Choy, Fyer, & Lipsitz,

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2007; McMurtry et al., 2015, 2016; Wolitzky-Taylor, Horowitz, Powers, & Telch, 2008). During in vivo exposure an individual is asked to come into contact with the feared stimulus, usually progressing from the least to most anxiety-provoking aspect of the stimulus (Choy et al., 2007). Despite success of established exposure protocols, major limitations include the need for skilled clinicians, a clinical environment, and significant expenditure of cost and time. Accordingly, there is need for relatively inexpensive, accessible, and innovative approaches to deliver exposure to feared stimuli associated with a variety of needle and blood-related procedures.

Recent research has begun to examine the potential utility of body illusions to facilitate exposure paradigms, which may address limitations of conventional treatments (Lenggenhager, Mouthon, & Blanke, 2009; Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2008). For example, the "rubber arm illusion", first introduced by Botvinick and Cohen in 1998 (Botvinick & Cohen, 1998), pairs tactile stimuli to one's actual arm with that observed on a rubber arm to induce a sense of "ownership" of the rubber arm. Drawing on recent research regarding optimal arm illusion parameters (Botvinick & Cohen, 1998; Christ & Reiner, 2014; Lloyd, 2007; Thakkar, Nichols, McIntosh, & Park, 2011; Tsakiris & Haggard, 2005), the present study examined an extension of this approach by testing simulated ownership of a human arm depicted in virtual/digital format to facilitate exposure to a simulated blood draw. The blood draw procedure was selected due to its relevance to both blood and needles stimuli as well as syncopal response. As such, we sought to establish a foundation for clinical application that could be adapted across various procedures that utilize blood and needle stimuli. Accordingly, the purpose of this preliminary study was to examine the feasibility of a virtual blood draw to generate a realistic subjective experience. Specifically, we examined (1) whether illusion of ownership was successfully induced, (2) the association between self-report measures relevant to blood and needles and presyncopal reactions in response the virtual blood draw, and (3) physiological responses over the course of exposure to the virtual blood draw protocol.

2. Materials and methods

2.1. Participants

Seventy-four undergraduate students participated in this study. Inclusion criteria included (a) age 18 or older, (b) having not donated blood more than once previously, and (c) no self-reported chronic medical conditions that might contraindicate participation in a potentially stressful exposure paradigm (e.g., cardiovascular disease). Potential participants were screened by phone for study inclusion. Participants were recruited from a Psychology Department research participation pool and received compensation in the form of course credit. All participants completed the entire study. All procedures were approved by the University of North Texas Institutional Review Board.

2.2. Self-report measures

2.2.1. State-Trait Anxiety Inventory: State Items (STAI-State; Julian, 2011)

Participant state anxiety was assessed through administration of STAI state items. The STAI-State contains 20 items in which respondents rate their agreement with statements conveying situational anxiety ("I feel nervous"; "I am tense") on a 4-point Likert scale (1 = not at all; 4 = very much so). Total scores are obtained for the subscale by summing the 20 items. Higher scores indicate greater state anxiety. Internal consistency (Cronbach's α) for the current sample was $\alpha = 0.91$.

2.2.2. Blood Donation Fears Inventory (BDFI; Kowalsky, France, France, Whitehouse, & Himawan, 2014)

The BDFI is an 18-item survey that assesses individuals' self-reported fear of blood donation across 4 domains (subscales) – syncopal symptoms (9 items), blood and needles (3 items), social evaluation (4 items), and health screen results (2 items). Each item is rated on a 5-point Likert scale (1 = not at all afraid or anxious; 5 = extremely afraid or anxious). Subscale scores are totaled and divided by the number of items on each subscale to generate an overall score. Higher scores indicate greater fear in each domain. Internal consistency for the total BDFI score in the current sample was $\alpha = .92$. Internal consistency scores for the subscales were as follows: syncopal symptoms ($\alpha = .96$), blood and needles ($\alpha = .92$), social evaluation ($\alpha = .78$), and health screen results ($\alpha = .91$).

2.2.3. The Fear of Injections and Blood Draws and Fear of Blood subscales of the Medical Fears Survey – Short Version (MFS-SV; Olatunji et al., 2012)

The Fear of Injections and Blood Draws (4 items) and Fear of Blood (5 items) subscales of the MFS-SV allow respondents to indicate the extent to which they experience fear of medically-related situations such receiving injections and giving blood, respectively. These subscales have been shown to predict vasovagal reactions to blood donation (Olatunji et al., 2012). Each item is rated on a five-point scale (0 = no fear at all; 4 = terror). For the current sample, internal consistency scores were $\alpha = .87$ for the Fear of Injections and Blood Draws subscale and $\alpha = .85$ for the Fear of Blood subscale.

2.2.4. Blood Donation Reactions Inventory (BDRI; France, Ditto, France, & Himawan, 2008)

Upon completion of the virtual arm protocol (described below), participants completed the 4-item BDRI. The BDRI assesses subjective physiologic reactions to blood donation associated with vasovagal syncope, including faintness, dizziness, weakness, and lightheadedness. Participants indicate the extent to which they experienced each of these symptoms on a 6-point Likert-type scale (0 = not at all; 5 = extremely); items are summed to provide a total reactions score. Total BDRI scores have a high level of internal consistency, positively correlate with phlebotomist ratings of vasovagal syncope reactions among blood donors, and predict likelihood of future donations (France et al., 2008). Internal consistency for the current sample was $\alpha = .90$.

2.2.5. Manipulation check

Following the virtual arm protocol, participants were asked two questions to assess the extent to which the virtual arm illusion was experienced as realistic. Specifically, participants were asked to respond to the statements "*I felt the touch of the brush on the digital arm*" and "*I felt as if the digital arm was my arm*" using a 10-point scale ranging from 0 (do not agree at all) to 9 (agree completely). These questions were adapted from earlier studies examining a standard rubber arm illusion (Botvinick & Cohen, 1998; Guterstam, Petkova, & Ehrsson, 2011; Kammers, de Vignemont, Verhagen, & Dijkerman, 2009) and were administered to capture the key perceptual components of the virtual arm protocol.

2.3. Physiological measures

2.3.1. Blood pressure and heart rate

Measures of systolic blood pressure (SBP, in mmHg), diastolic blood pressure (DBP, in mmHg), and heart rate (HR, in beats per minute) were obtained using a Dinamap® V100 Digital Blood Pressure monitor. Appropriately-sized blood pressure cuffs were secured to participants' upper left arm and inflated at key phases of the protocol.

2.3.2. Electrodermal activity

Continuous monitoring of electrodermal activity (EDA, in micromhos) was collected using a BIOPAC® MP150 data acquisition system connected to an EDA100C amplifier with two LEAD100 electrodes taped to the middle phalanges of the participants' middle and index fingers. AcqKnowledge®, Version 4 software was used to process the