

ANXIETY AND STRESS IN LIVE DISASTER EXERCISES



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CE Earn Up to 7.5 Hours. See page 470.

Contribution to Emergency Nursing Practice

- The current state of scientific knowledge on anxiety and stress in live disaster exercises indicates that there is need for additional rigorous studies in this area.
- The main finding of this research is that live disaster exercises resulted in increased perceived anxiety in participants, with corresponding stress-related biomarkers within normal limits.
- Key implications for emergency nursing practice from this research are that live exercises are reported by participants to cause anxiety. Further research related to disaster training and preparation for optimal disaster response is needed.

Abstract

Introduction: Nurses play critical roles in disaster response, often preparing through simulated exercises. According to The NLN Jeffries Simulation Theory, simulations can lead to anxiety in participants that affects learning. The objective of this research was to measure and describe anxiety and stress levels of participants in a live disaster-training exercise.

Methods: A quasiexperimental/descriptive design using quantitative methods (amylase, cortisol levels) and qualitative methods (survey, focus groups) was used with a convenience sample of senior nursing students taking part in a disaster exercise. Participants completed self-reports of anxiety before and after the exercise using the State-Trait Anxiety Inventory (pre/post). Following the training, participants provided saliva samples for analysis of cortisol and amylase levels to measure physiological stress levels. Participants were also invited to take part in a focus group after exercise participation.

Results: A total of 22 participants were recruited. Significant elevation of self-reported anxiety levels was found on the State-Anxiety Inventory comparing pre- with post-training, but no Trait-Anxiety changes were noted. Amylase and cortisol levels were within normal ranges. Themes emerging from qualitative analysis include preparation, uncertainty, teamwork, realism, and decision making.

Discussion: Disaster training may be anxiety provoking and stressful. ED nurses should consider how to include best practice approaches for simulation in design of exercises to prepare for the increasing number of multicasualty events.

Key words: Disaster exercise; Stress; Anxiety; Simulation

Nurses play critical roles in preparing for, responding to, and recovering from disasters. The *Future of Nursing* report calls upon nurses to

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assume leadership roles in preparing for and responding to disasters.¹ The Centers for Medicare and Medicaid (CMS)² mandates that health care agencies “Develop and maintain training and testing programs, including initial and annual trainings, and conduct drills and exercises or participate in an actual incident that tests the plan.” In addition, The Joint Commission³ standards emphasize the need to practice the emergency operations plan, which is accomplished through exercises and drills. This is especially true for nurses in emergency departments at the front line, responding to multicasualty events; the Emergency Nurses Association⁴ acknowledges that emergency nurses are a critical resource in emergency response, requiring participation in all-hazards approach emergency training exercises. There is a high level of emphasis on the participation in live exercises and drills as a method of training for disasters,⁵ which may cause anxiety and stress for participants.

Conceptual Framework/Review of the Literature

The NLN Jeffries Simulation Theory⁶ includes concepts for inclusion in simulations such as context, background, simulation design, facilitation strategies, and outcomes of simulation. According to this theory,⁶ participants are an important consideration when developing and evaluating a simulation experience; anxiety levels are a participant-related variable, which affects the simulation experience and learning.

REVIEW OF THE STRESS RELATED SIMULATION LITERATURE

Stress can cause biological and psychological responses. (See [Supplementary Material](#), “Stress and Anxiety” in the online version of this article).^{7–9} Simulated experiences have specifically been found to have a positive impact on ED nurses, such as development of emergency triage skills.¹⁰ In a search of the scientific literature, little is available to understand the level of stress in participants in a live disaster exercise and how it affects performance. In studies of simulated emergencies, researchers have described biomarker elevation of cortisol and alpha-amylase levels as stress-response indicators and found higher levels of alpha amylase in response to the simulation experience.^{10–15} Fernández-Pacheco et al⁹ conducted a study of undergraduate and graduate nursing students taking part in a mass casualty exercise and found that stress was identified, but level of stress was not related to academic level or performance.

Specific Aims/Purposes

The objective of this research was to measure and describe anxiety and stress levels of participants in a live disaster training exercise to aid in better understanding the phenomenon. The first specific aim was to measure the level of stress of exercise participants using biomarkers and pre/post self-reports of anxiety (survey). The second specific aim was to explore the experiential effects of stress as perceived by live exercise participants through the use of focus groups. Ultimately, this study will serve as a basis for future studies seeking the development of strategies to modulate stress levels and improve performance in actual disasters.

Methods

DESIGN

This study employed a mixed methods quasiexperimental/descriptive design using quantitative dominant method (cortisol/alpha amylase levels) supplemented with qualitative methods (survey, focus groups).

SAMPLE AND SETTING

Study participants included a convenience sample of undergraduate nursing students enrolled in an elective interprofessional disaster course. The course was run twice each academic year, with an enrollment of approximately 10 students each semester. Inclusion criteria included enrollment in the disaster course. The study was approved by the university Institutional Review Board (IRB), and risks to students were found to be minimal. To minimize the greatest risk of fear or coercion to participate, the informed-consent process was completed by a coinvestigator to blind participation to the principal investigator, who was also the instructor for the course.

The disaster nursing elective is part of the larger National Disaster Health Course (NDHC), a program that includes both online and on-site components and culminates in a live exercise the final day of the program. The culminating onsite component is designed to provide participants with hands-on experiences in a variety of disaster situations over 4 days. The final day is devoted to evaluation of the students' knowledge in an unfolding/iterative live disaster exercise, which is assessed using trained evaluators.

The cumulative exercise (final day) was developed using the Department of Homeland and Security Exercise and Evaluation Program (HSEEP) principles.¹⁴ The HSEEP principles of exercise and development, exercise conduct (operations-based), and evaluation were incorporated. In addition, the best practices of simulation as developed by International Nursing Association for Clinical Simulation and Learning (INACSL) Standards Committee,¹⁵ including principles of preparation and prebriefing, professional integrity, and debriefing were used to develop the exercise. The concepts from INACSL served to enhance the HSEEP methodology by adding depth and clarity to exercise conduct and evaluation. The same case scenarios were performed in an iterative manner 5 times throughout the day. Participants worked in teams to participate in each of the following rotations throughout the day: (1) emergency operations center, (2) triage and first aid, (3) retriage and transport, (4) surge response, and (5) sheltering. Performance in the exercises was observed and assessed by trained evaluators. Participant performance was measured in terms of team performance within the exercise, using rubrics based on course objectives and target capabilities as developed by HSEEP.¹⁴ All participants were required to complete the live exercise as part of the course requirements; however, participation in the study (self-report instruments, collection of saliva, focus-group participation) was optional.

MEASURES

State-Trait Anxiety Inventory

Participant stress and anxiety was measured using the State-Trait Anxiety Inventory (STAI), an instrument developed to assess both the state and trait of anxiety in research and clinical practice.¹⁶ The scale measures the intensity of an emotional response (state anxiety) and an individual's inclination toward an anxious response (trait anxiety). The STAI is a 40-item scale (4-point Likert-type scale), using responses from "Almost Never" to "Almost Always" to measure levels of anxiety. Twenty of the items are used to assess the "state" of anxiety, whereas 20 items assess the "trait" of anxiety. Scoring is based on a scoring rubric, with a possible score range of 20 to 40 for both the state and trait of anxiety.¹⁶ Higher scores are indicative of higher levels of both the state and trait of anxiety. Cronbach alphas range from 0.85 to 0.95. A paper-and-pencil version of the scale was administered before the disaster training and immediately after the live exercise.

Cortisol and Alpha Amylase

Cortisol and amylase were used to measure the physiologic response to stress. The 2 primary systems are responsible for responding to a psychological stressor: sympathetic-adrenal-medullary (SAM) system and hypothalamus-pituitary-adrenocortical axis (HPA). The activation of the former system results in the release of salivary alpha amylase and the activation of the second leads to the secretion of cortisol.^{17,18} Cortisol is a stress hormone produced from the adrenal cortex, which can be measured in saliva. According to Kirschbaum and Hellhammer,¹⁷ salivary cortisol is a "sensitive measure in stress research" and is described as a "convenient and reliable parameter of endocrine stress responses."¹⁷

Cortisol awakening response (CAR) is the cortisol secretory response that occurs immediately after awakening. Cortisol exhibits a diurnal pattern of secretion, resulting in an approximately 50% increase of cortisol within peaking 20 to 30 minutes of awakening, with a gradual decline throughout the day. Similar results are thought to occur with alpha amylase, but further research is needed.¹⁹ Sleep-related factors—such as awakening time, duration, and quality—have been studied with inconsistent results. Growing evidence shows an inverse association of CAR with chronic stress. In addition, low socioeconomic status may suppress CAR. Shift work has also been associated with dampening of CAR.²⁰

In response to sympathetic nervous system stimulation, alpha amylase is secreted by the salivary gland. Valentin et al¹² explained that alpha amylase levels are increased during times of psychological stress. Nater and Rohleder²¹ have reported that salivary amylase is also a noninvasive biomarker of stress. Both biomarkers were measured post-disaster training using saliva samples and served as measures of the stress response. The biomarkers were not assessed pre-exercise, as the results likely would have been within the elevated CAR period. The researchers chose to compare levels to laboratory determined norms to assess for elevation.

Focus Group Interview Guide

A focus group discussion guide (Supplementary Figure, "Focus-Group Questions") was developed by the researchers, based upon the NLN Jeffries Simulation Theory⁶ and used to elicit participant responses related to the participant exercise experience. The interview guide included 10 open-ended questions and were followed with additional questions, as needed, to clarify participant responses.

PROCEDURES FOR DATA COLLECTION

All participants who completed the study protocol (self-report instruments and saliva sample) received an incentive in the form of a \$15 gift card to a local retail establishment, as approved by the local IRB; participants who took part in the focus-group interview were provided with an additional \$10 gift card incentive. The study was conducted at the university's National Center for Medical Readiness (NCMR), a 50-acre former cement plant that has been transformed into a disaster-preparation training complex. The 5 disaster training stations were set up across the training complex both indoors and outdoors. Two cohorts of students were invited to participate in the study face-to-face (1 in fall of 2017 and 1 in spring of 2018). On the first day of on-site training at NCMR, all participants were provided an overview of the study and invited to participate in the study by the coinvestigator. Following consent, participants completed a paper-and-pencil version of the 40-item STAI¹⁶ that included collection of limited demographic characteristics. Following completion of the live exercise triage station on the final day of on-site training, participants again completed the STAI and provided saliva specimens for measurement of cortisol and alpha amylase. Because of the early start time of the disaster exercise, an initial specimen was not collected so as to avoid high levels encountered during the CAR response. Instead, comparison with laboratory norms were used.

TABLE 1
Demographics

Gender	Number	Age Mean	Age Range	Students
Female	15	23.2	21-30	16
Male	5	24.8	23-26	6
Total	22*			2

* Two participants did not respond to questions of gender/age.

The laboratory protocol for specimen collection procedures was based on the procedures provided by Salimetrics,²² the laboratory used to process the specimens. Factors such as diet, nicotine, and exercise may affect salivary cortisol and alpha amylase.²³ The mouth was rinsed with water prior to obtaining the specimen. The participants did not engage in any rigorous exercise the day of the simulation. Saliva samples were collected using oral swabs (tips untouched) placed on the floor of the mouth until saturated (under the tongue). Time of collection was recorded (flow rate). Participants did not brush teeth, ingest food/drink, smoke within 30 minutes prior to specimen collection. Specimens were collected within 15 minutes of completion of the exercise and placed in the freezer within 15 minutes of collection and transported to the laboratory on dry ice.

Two focus-group interviews were conducted at the university after each of the 2 cohorts completed the on-site live training exercise. Focus groups consisted of 4 to 5 participants facilitated by the coinvestigator, who is a PhD-prepared qualitative researcher and faculty member in the college of nursing. Although all participants were invited to the focus-group sessions, only 9 of the 22 total students chose to participate; it is not known why all did not choose to participate. Both focus groups were audiorecorded with participant permission, and recordings were transcribed verbatim. The transcribed responses to the interview questions were analyzed by the investigators individually for themes and patterns, using a constant comparative analysis approach.²⁴ Both researchers analyzing the focus-group data were nurse scientists trained and experienced in qualitative methods. After individual analysis, the investigators reviewed the transcripts for themes, together using qualitative methods appropriate to maintain trustworthiness and rigor. Because participants had graduated, transcripts were not returned for member checks as would be suggested by Glaser and Strauss.²⁵ However, it was found that the point of saturation was reached as additional data collected following the first focus group yielded no new understandings of the experience with the second focus-group data.

Results

QUANTITATIVE ANALYSIS

A total of 22 participants provided consent to participate in the study over 2 semesters (100% of eligible participants). Participants were all baccalaureate (BSN) students. Twenty-one were traditional BSN students in their last semester of their program of study; 1 was a RN-BSN completion student. Of those reporting demographic characteristics, age of participants ages ranged from 21 to 30 years of age; 75% were women (Table 1).

The results on the STAI²⁰ questionnaire on Y-1 (State) measure included a mean score of 31.18 preintervention and 41.09 postintervention (Table 2). Differences between pre and post results were compared using paired Students' *t*-tests (SPSS Version 24, IBM, Armonk, NY). The postexercise State anxiety (Y-1) measure was significantly higher ($P = 0.000861$, $t = -3.822$, $df = 21$) than measurement pre-exercise. Comparison of the Trait (Y-2) dimension of the STAI questionnaire means were 33.45 preintervention and 35.56 postintervention. There was no significant difference between scores ($P = 0.177$, $t = -1.40$, $df = 21$). Normative laboratory values were used to determine elevation of biomarkers. Amylase levels were all within normal range levels (34.6 to 259.8), and cortisol levels were within normal range (0.062 to 1.241) (Table 2).

QUALITATIVE ANALYSIS

The following 5 themes emerged from the analysis: preparation, uncertainty, teamwork, realism, and decision making (see Table 3 for summarization of themes and exemplars). Based on focus-group feedback, suggestions emerged for identifying how to minimize the impact of stress and anxiety of a multicasualty disaster-training exercise.

Discussion

In this study, participation in a live disaster exercise resulted in elevated anxiety in participants as evidenced by significantly higher post-training scores on the State anxiety (Y-1) questionnaire and focus-group findings. Our findings support those of Fernández-Pacheco et al,⁹ who found that a multicasualty simulation resulted in stress in participants as measured by alpha-amylase (αA), heart rate, and blood pressure. This previous study also found higher levels of stress in participants who performed triage, which also correlates with the focus-group findings in this study in which participants identified anxiety in making decisions, especially regarding level of triage (Table 2).

TABLE 2
Results

Measurement	Pretest Mean/Range	Post-Test Mean/Range	Standard Deviation	95% CI Lower/Upper	t Value	t Test Comparison Pre/Post P Value	College-Age Population Norms
Y-1 State	31.18 (20-56)	41.09 (20-60)	11.71	-15.21 -4.60	-3.822	0.000861*	Mean 38.76 women +/- 11.95 SD Mean 36.47 men +/- 10.02 SD
Y-2 (Trait)	33.45 (20-56)	35.36 (20-58)	6.42	-4.76 .957	-1.40	0.1777	Mean 38.30 men +/- 9.18 Mean 40.40 women +/- 10.15
Amylase	N/A	93.4 µg/mL Range (4.6-259.8)				N/A	Range 3.1-423.1 µg/mL
Cortisol	N/A	0.279 µg/dL Range 0.062-1.241 µg/mL				N/A	Range 0.112-0.743 µg/dL men Range 0.272-1.348 µg/dL women

CI, confidence interval; SD, standard deviation.

* Indicates significance at $P < 0.05$.

In the current study, neither alpha-amylase nor cortisol were above established norms. This supports the findings of the results of Boudarene et al,²⁶ who postulated that demonstration of state anxiety is the “first stress response and primary protest.” State anxiety is exhibited until it obtains a plateau level and then is stable. At this point, the stress response becomes biological with increased cortisol levels as “second protest,” giving evidence of a more intense prolonged stress response. The stress level is supported by the focus-group findings of participants reporting that the exercise was “nerve-wracking” and difficult in terms of decisions for individual patients and as a leader of a team. However, participants commented that they knew they were not in actual danger and that they were aware that many patients were mannequins, not real patients, indicating the levels of stress may not have been overwhelming in this case. In addition, McGuire and Lorenz,²⁷ in their integrative review of stress and cortisol levels, found that high levels of stress always lead to impeded performance. Yet team participant performance on the final exercise indicated “passing” performance based on scores on the grading rubric used by the exercise evaluators in this study.

The normal biomarker results in study participants may indicate healthy, performance-enhancing levels of stress, chronic stress, CAR, sleep deprivation, or other unmeasured dampening factors worthy of additional study. Just as simulation can help prepare health care providers to care for treating individual patients, live disaster exercises are simulated experiences that can help prepare practitioners for multicasualty disaster experiences. Based on the NLN Jeffries Simulation Theory,⁶ the participant’s experience must be understood and considered to design and implement an effective simulated experience. Although some anxiety is beneficial in simulation, higher levels may impede ability to focus on tasks and affect learning.⁹ It is up to the exercise director/educator to evaluate levels of stress and effects on performance.

In the qualitative findings, participants emphasized the importance of preparation for the multicasualty disaster-training exercise. Participants articulated how they were prepared or not prepared to take on the challenges of the simulated event. Simulation standards, like those from INACSL, should be used to design and implement a live disaster exercise simulation to implement the desired training objectives. This includes ensuring that participants have adequate prebriefing to prepare them for the simulation, support during the simulation appropriate to the participants and objectives, and an evidence-based debriefing post-training that may have significance in preventing high levels of stress during training exercises.

Another aspect identified by the participants in this study was the importance of teamwork. The participants

TABLE 3

Qualitative themes

Theme and Description	Participant Exemplars
<p><i>Preparation</i> This theme reflects the participants' thoughts about their readiness for the live training exercise.</p>	<p>"Showed how not ready I was for the experience...so now feedback really gave me like an open mind and what to do next." "I was not ready for the emotional side of it." "If they had a second one, we would feel like more prepared than we did the first time."</p>
<p><i>Uncertainty</i> This theme reflects the participants' thoughts about their level of surety/level of confidence in situations confronted in the live training exercise.</p>	<p>"Not having a lot of those injuries before. Like how am I going to deal with that patient?" "...our anxiety was a little bit higher at the beginning. But lowered as we went through it." "With each exercise, I feel I got better, and so I had knowledge that I could apply to the next one." "It was stressful because there was so much unknown." "I thought it was nerve-wracking. Not having had a lot of those injuries before." "Having worked together throughout the week was helpful....we could rely on each other."</p>
<p><i>Teamwork</i> This theme reflects the participants' thoughts about the group-based aspect of the live training exercise.</p>	<p>"It's nice coming in knowing everyone's strengths." "It was a multidisciplinary team...not all nurses..they contribute to different areas." "We worked really well as a team." "I think my only stress was, like, I was in charge of that group."</p>
<p><i>Realism</i> This theme reflects the participants' thoughts regarding the authenticity and fidelity of the live training experience.</p>	<p>"And, they're very good actors, so they were good." "There are going to be patients like this, and you need to know how to handle it." "It was a simulated disaster, but I had those real feelings of being in that situation."</p>
<p><i>Decision making</i> This theme reflects the participants' thoughts regarding decisions and choices that needed to be made as part of the live training exercise.</p>	<p>"I walked in there and saw unconscious people laying around. It's like, where am I going first?" "It's hard to get out of my head that we cannot save everyone. That is difficult. I want to save everyone." "I'm just very scared of making mistakes...You worry about being wrong but you're more concerned about doing whatever you can in the moment." "What if I make the wrong decision?" "It was sort of like nerve-wracking to go there and then when we arrived, we just like started our interventions, like, without even thinking about it." "You worry about making that mistake that would kill somebody."</p>

commented on how they had worked with those in their on-site exercise group and the importance of knowing individual strengths when participating in the exercise itself. Training of ED nurses in teams who would most likely respond together, would promote understanding individual strengths to improve patient care outcomes in an actual disaster event, as well as address issues of stress in disaster training.

Participants identified the stressful nature of making decisions in a disaster exercise. Although ED nurses are frequently required to make decisions rapidly, decisions made in a multicasualty exercise may be even more stressful, such as triaging a casualty as "dead" rather than attempting

to resuscitate. Having opportunities to practice the decision making of mass casualty triage is an important component to include in any disaster-training exercises. The participants discussed the level of realism of the disaster training exercise. Realism is an important component of simulation educational design, which includes understanding the participant's responses to the level of realism as their response is affected by their broader healthcare experiences.²⁸ In addition to promoting realism, encouraging the meaningfulness of the simulated event can enhance the learning environment and having input from ED nurses about how to make the experience meaningful with the restraint constraints of the institution.

LIMITATIONS

This study is limited by the small sample size from 1 public nursing program, which may affect the generalizability of findings. In addition, study participants were undergraduate nursing students; therefore, their responses may not be the same as those practicing nurses, including ED nurses. Physiological measurements were limited to amylase and cortisol levels, which were measured post-training, so there is no comparison to determine if measurements changed as part of the training exercise. In addition, limited demographic data were collected and did not include characteristics such as health care experience, disaster experience, or other simulation experience that may have affected results. Future studies are needed with larger sample sizes and both pre- and post-training testing to determine how stress levels in exercises affect performance in a way to identify best practice approaches for disaster training, including how participant characteristics might affect performance. In addition, the study did not address stress in actual disaster response activities, when levels of anxiety may be increased due to the “real” nature of the event during a time when nurses may also be concerned about their own personal and family safety.

Implications for Emergency Nurses

ED nurses have been identified as being susceptible to stress from the fast-paced decision making and complex care needs of patients they encounter. The addition of managing patient care during or following a disaster or multicasualty event may provoke even higher levels of stress.²³ Given that disaster preparation is an important component of ED nurse training, any training must developed acknowledging the potential for stress and anxiety that may have an impact on performance.

In addition, given the interprofessional nature of disaster response, and findings in this study related to the importance of teams, training of ED nurses should also consider the interprofessional nature of disaster response as conducted in this study. Emphasizing interprofessional team-based concepts, such as the Agency for Healthcare Research and Quality (AHRQ) framework of TeamSTEPPS (AHRQ, Rockville, MD), could be incorporated to guide health care personnel on the important aspects of interprofessional operations.²⁹ TeamSTEPPS principles, which include leadership, situation monitoring, communication, team structure, and mutual support, could be used to promote team-based operations in a way that promotes development of skills that can be used in disaster training and response.

Conclusions

The objective of the study was to measure and describe anxiety and stress levels of participants in live disaster exercises. Our findings indicate that partaking in disaster exercises is self-reported as stressful by participants. High levels of stress may impede performance, leading to poor learning from simulation.^{9,27} The experiences of study participants was reported to be affected by preparation, uncertainty, team performance, realism, and decision making. Further research is needed to understand how these factors can manage stress levels for optimal learning during live exercise.

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Supplementary Material

Stress and Anxiety

According to Bong, Fraser, and Oriol¹ physical stress is a biological response that causes activation of the sympathetic nervous system (SNS), which ultimately causes the pituitary gland to release adrenocorticotropin hormone (ACTH). This subsequently leads to a release of cortisol from the adrenal glands. This process activates the flight or fight response, which produces symptoms of increased heart rate, high blood pressure, and increased respiratory rate.

Psychologically, when a person feels overwhelmed by stress, the response leads to a negative psychological state known as anxiety.¹

Within a heightened stress environment, individuals will also have cognitive deficits such as difficulty with working memory, attention to detail, and making decisive decisions. There are certain levels of stress that are beneficial

to a person's performance; however, according to the Yerkes-Dodson Law² on stress and performance, stress can only increase up to a certain level before inhibiting performance. Bong et al¹ explained that situations inducing the stress response include situations that are either new, novel, variable, or labile and are perceived as not well controlled. Simulated disaster-training exercises have the potential to induce stress for these reasons and have been shown, at a minimum, to induce physiologically measurable stress response.³

REFERENCES

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2. Yerkes RM, Dodson JD. The relationship of strength of stimulus to rapidity of habit formation. *J Comp Neurol Psychol*. 1908;18:459-482.
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1. Did you feel prepared for the live exercise?
2. How did it feel to care for a moulaged patient?
3. Did the situation feel realistic to you?
4. How did it feel making decisions about patients?
5. Did you think about making mistakes?
6. How did it feel to make decisions quickly?
7. What were your general feelings during the entire simulation?
8. How did you feel about receiving feedback on your performance?
9. Did performing in front of others affect your performance?
10. Did you feel stressed by the live exercise? Why or Why not?

SUPPLEMENTARY FIGURE

Focus group questions.