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## ORIGINAL ARTICLE

# Human experimental anxiety: actual public speaking induces more intense physiological responses than simulated public speaking

Antonio Waldo Zuardi, José Alexandre de Souza Crippa, Jaime Eduardo Cecílio Hallak, Ricardo Gorayeb

*Department of Neuroscience and Behavioral Science, School of Medicine, Universidade de São Paulo (USP), Ribeirão Preto, SP, Brazil.*

**Objectives:** a) To perform a systematic and meta-analytic review to verify whether the Simulated Public Speaking Task (SPST) leads to a greater increase in self-rated anxiety than in physiological correlates of anxiety; and b) to compare the results obtained with the SPST with an actual public speaking task involving healthy volunteers.
**Methods:** a) The PubMed and ISI Web of Knowledge databases were searched for studies involving the SPST prior to 2012. Eleven publications were eligible and provided data from 143 healthy volunteers for meta-analysis; b) 48 university students without somatic or psychiatric disorders were divided into three experimental groups of 16 subjects to undergo one of the following: SPST, real-world public speaking task (real-world), and control situation (control).
**Results:** The meta-analysis showed that the SPST induced a significant increase in the Visual Analogue Mood Scale (VAMS) anxiety factor, but no significant increases in systolic blood pressure or heart rate. The empirical study showed that the real-world public speaking task increased heart rate, systolic blood pressure and diastolic blood pressure significantly more than the control and SPST conditions.
**Conclusions:** These results suggest that real public speaking might be better than SPST in inducing experimental anxiety.

**Keywords:** Experimental anxiety; public speaking; simulated; real-world; meta-analysis

## Introduction

When developing new anxiolytic compounds or investigating the pathophysiology of anxiety disorders, tasks that induce experimental anxiety in human beings may constitute a helpful bridge between animal models of anxiety and clinical disorders.[1] Several types of stimuli have been used as laboratory stressors, including physical (e.g., exercise), pharmacological (e.g., lactate), and psychological stimuli (e.g., cognitive tasks, public speaking tasks, aversive conditioning to noises, emotion induction procedures).

Since the fear of public speaking is highly prevalent in the population,[2,3] McNair et al.[4] developed and validated a Simulated Public Speaking Task (SPST) to be used as a psychological stressor in experimental studies. In this task, participants are invited to prepare a speech then deliver it in front of a video camera, after having been informed that the video would be analyzed by a psychologist. Participants also fill out self-evaluation rating scales and undergo physiological assessments (e.g., blood pressure, heart rate, skin conductance, cortisol plasma levels) before, during and after the speech. An increase in anxiety is observed after the preparation period, before the subject starts speaking (Anticipatory Anxiety Measure) and in the middle of the speech (Performance Anxiety Measure). This procedure has been extensively used in studies of anxiolytic and anxiogenic drugs.[1,6] The SPST has been shown to increase self-rated anxiety regardless of participants' trait anxiety.[6] However, the results of physiological measures of anxiety have been less consistent, with some studies finding an increase in these measures[7] and others finding no significant change after the SPST.[8]

The hypothesis that SPST induces a marked increase in subjective anxiety but is associated with more variable results in physiological measures of anxiety needs to be confirmed by a systematic literature review.

A more dramatic effect on physiological correlates of anxiety, such as blood pressure, heart rate (HR), and cortisol secretion, has been observed in actual public speaking before a small audience.[9,10] Although actual public speaking tasks have been used in the past,[11-13] this method has been criticized by some because it is difficult to secure a ''standardized'' audience for all subjects.[13] Training the audience[14] or showing a video recording of an audience to all volunteers[13] were attempts to mitigate this limitation, although neither

Correspondence: Antonio Waldo Zuardi, MD, PhD, Department of Neuroscience and Behavioral Science, School of Medicine, Universidade de São Paulo, Av. Bandeirantes, 3900, CEP 14048-900, Ribeirão Preto, SP, Brazil.
E-mail: awzuardi@fmrp.usp.br
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method was fully equivalent to a real-world public speaking situation. A more similar alternative to real-world public speaking is the natural task proposed by Turner et al.,[9] in which subjects speak in front of a small audience composed of other individuals who should also take turns speaking in front of the group. The hypothesis that public speaking in a condition close to the real situation could induce more intense physiological responses than the SPST could be tested by comparing the two models in the same experiment.

The objectives of this study were two-fold: a) to perform a systematic and meta-analytic review to verify whether the SPST has a greater effect on increasing self-rated anxiety than physiological correlates of anxiety and; b) to compare the responses to the SPST with the effect of an actual public speaking task in healthy volunteers.

## Material and methods

*Experiment 1: meta-analysis*

Studies were identified using the keywords ''simulated'' and ''public'' and ''speaking'' in searches of the MEDLINE and ISI Web of Knowledge databases for articles published up to 2012. References of selected articles were also hand-searched for possible additional citations.

To be included in this review, studies had to meet the following criteria: a) full article published in English; b) use of SPST as a stimulus to induce anxiety; c) presence of a comparison group of healthy volunteers.

In order to standardize the SPST protocol in the studies, only articles that used the protocol proposed by McNair et al.[4] were analyzed. Briefly, this protocol includes: a) a short period of adaptation to laboratory conditions followed by the baseline assessment (psychological and physiological measures); b) a pre-test habituation period with or without pharmacological challenge followed by the pretest measures; c) provision of information about the SPST procedure, specifically that the speech would be recorded in video and analyzed by a psychologist; d) 2 minutes to prepare a 4-minute speech about a pre-established topic; e) anticipatory speech measures before the subject started speaking; f) speech given by participant in front of a camera, while the image is broadcasted to a television screen, which the participant can watch during their performance; g) speech interruption for performance measures; h) post test measures.

In the present analysis, three measures were investigated: the anxiety factor of the Visual Analog Mood Scale (VAMS-Anxiety),[15-17] systolic blood pressure (SBP), and the HR. For each measure, baseline and speech performance measures were compared with those of the healthy volunteers used as control in each study.

Effect size and 95% confidence intervals (95%CI) were used as indicators of significant increases in assessment scores. The effect size was estimated based on the standardized mean-change, using Becker's d index ($d = [mean_{post\text{-}stressor} - mean_{pre\text{-}stressor}] / SD_{pre\text{-}stressor}$), which is appropriate for repeated measures effect size estimates.[18-20] The 95%CI was calculated with the formula: (95%CI = d $\pm$ asymptotic standard error).[21] The overall weighted effect size was calculated according to the formula ($\sum[di*Ni] / \sum Ni$).

*Experiment 2: empirical study*

### Subjects

Forty-eight university students without somatic or psychiatric disorders were selected for the empirical study. Participants were divided into three groups of 16 subjects each and underwent one of the following procedures: SPST, real-world public speaking task (real-world) and control situation (control). The groups were matched for sex and age. Informed consent was obtained from all participants, and the study was approved by the Regional Research Ethics Committee.

### Psychological measurements

State-anxiety levels were evaluated using a VAMS[15] translated into Portuguese.[16] In this scale, the subject is shown a piece of paper with a 100-mm long line connecting two words that describe opposite mood states. Participants are then asked to indicate a point on the line that corresponds to his/her current emotional state. The VAMS contains 16 items, which have been shown by Norris to comprise four different factors. A factor analysis of the Portuguese version of the VAMS also yielded four factors with similar item composition.[17] The present study used the VAMS-Anxiety factor, which comprises the items calm-excited, relaxed-tense, and tranquil-troubled.

### Physiological measurements

SBP, diastolic blood pressure (DBP), and HR were measured using a digital sphygmomanometer (Omron, Brazil).

### Procedure

Subjects in the SPST group were individually evaluated in a room with sound attenuation and temperature control. The SPST procedure was similar to that used by McNair et al.[4] Soon after the subject's arrival, initial measures (baseline) were taken, followed by a period of 20 minutes without stimulation, after which the researcher played a videotape with the task instructions. The subject was told that he/she would have 2 minutes to prepare a speech about local public transportation, intended to be an emotionally neutral topic, and that it would be interrupted midway through for the administration of assessment scales. He or she was also told that the speech would be video recorded and later analyzed by a psychologist. After the 2-minute preparation period, the subject started speaking in front of the camera, while viewing his or her own image on a TV screen. The performance was interrupted midway through so that speech performance (Speech) measurements could be taken. The final 2 minutes of the speech were recorded. Final measures (Final) were taken 15 minutes after the end of the speech.

The real-world public speaking task (real-world) is based on the naturalistic task proposed by Turner et al.[9] in which the subjects were required to deliver their speech in front of an audience. This real-world stressor is a realistic representation of a situation that university students face during their professional training.

The subjects in the real-world and control groups took part in the same experimental session in a conference room. However, each subject in the real-world group spoke in front of the other subjects (real-world and control group - 32 subjects) and two researchers, while participants in the control group acted only as audience members. The audience was the same for all speakers. The initial measures (baseline) of the two groups (real-world and control) were taken soon after the subject's arrival, followed by a period of 20 minutes without stimulation. At this point, information about the task assigned to the two groups was provided. Subjects in the real-world group were required to prepare a 2-minute speech minutes about a public service in their city (eg., transportation, education, health) which would be randomly selected 2 minutes before the start of each speech. Subjects in the control group were told that he/she should evaluate the performance of one specific subject in the real-world group, with whom they were paired for the session. Subjects in the real-world group were asked to sit in front of the others and give their presentation. The presentation order was randomly determined. The speech was interrupted after 1 minute so that speech performance measures (Speech) could be taken, after which the speech continued for 1 more minute. After the end of the speech, physiological measures of the paired control subjects were also taken. Fifteen minutes after these procedures, the final assessments (Final) were made.

### Data analysis

Demographic characteristics were analyzed using the Chi-square test (gender) and one-way analysis of variance (ANOVA - age). VAMS-Anxiety scores (VAMS-Anxiety), HR, SBP, and DBP were transformed by calculating the difference between the scores at each time point and the baseline score for the same volunteer. These delta scores were submitted to a repeated-measures analysis of variance (rmANOVA). Whenever a significant time by group interaction occurred, between-comparisons were made using an ANOVA followed by Bonferroni test for multiple comparisons.

## Results

### *Experiment 1: meta-analysis*

Figure 1 shows the study selection process for the meta-analysis. From the 51 studies identified by the keywords in the literature search, 26 met the inclusion criteria. Two studies identified in the reference sections of other articles were also included. Of the total number of articles included, 12 were excluded because the McNair protocol was not used. The 16 studies that used the McNair protocol were read and summarized in Table 1. However, five of these studies were excluded from the analysis for not reporting means, standard deviations, standard errors, or t statistics. Thus, 11 studies were included in the meta-analysis. These studies provided comparative data for a total of 143 healthy volunteers.

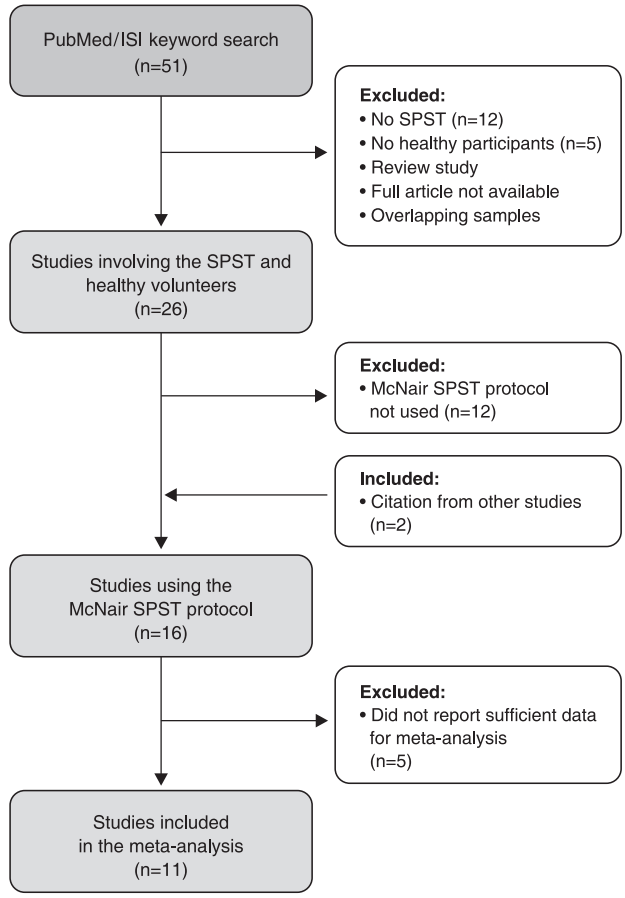



**Figure 1** Flow chart showing study selection for meta-analysis. SPST = Simulated Public Speaking Task.

The effect size of the SPST on VAMS-Anxiety, SBP, and HR in each study is presented in Figure 2. Overall, effect sizes in the selected studies were as follow: 1.2 (VAMS-Anxiety), 0.62 (SBP) and 0.39 (HR). The overall effect size on VAMS-Anxiety was statistically significant, demonstrating that SPST significantly increases self-rated anxiety (mean of 1.2 standard deviations above pre-stress baseline values). Results regarding the effect of the SPST on SBP and HR were not statistically significant.

### *Experiment 2: empirical study*

The groups were successfully matched according to sex ($\chi^2 = 2.182$; $p = 0.336$), age ($F_{2,47} = 1.646$; $p = 0.204$) and baseline VAMS-Anxiety scores (($F_{2,47} = 2.151$; $p = 0.128$). The male/female ratios were 11/5, 7/9 and 8/8, and the mean age was 21.44, 22.00 and 21.00 years, respectively, for the control, real-world and SPST groups.

**Table 1** Characterization of the 16 studies that used the McNair SPST protocol

| Reference | Experimental groups | Control group characteristics | | Sufficient data for meta-analysis |
|---|---|---|---|---|
| | | n (M/F) | Age (years) | |
| McNair et al.[4] | Diazepam | 31 (31/0) | (18-30) | No |
| Guimaraes et al.[22] | Chlorimipramine, maprotilime, lorazepam | 10 (4/6) | (19-34) | No |
| Zuardi et al.[13] | Cannabidiol, ipsapirone, diazepam | 10 (5/5) | (20-30) | VAMS-Anxiety, SBP |
| Kapczinski et al.[23] | Flumazenil | 10 (5/5) | (18-43) | No |
| Palma et al.[6] | SPST x STROOP | 7 (3/4)* | - | VAMS-Anxiety |
| Hetem et al.[8] | D - Fenfluramine | 14 (9/5) | (18-36) | VAMS-Anxiety, SBP |
| Guimaraes et al.[24] | Ritanserin | 15 (4/11) | (18-34) | No |
| Del Ben et al.[25] | Panic patients | 17 (8/9) | (18-40) | VAMS-Anxiety |
| Monteiro et al.[26] | Tryptophan depletion | 15 (8/7) | (18-35) | VAMS-Anxiety |
| Shansis et al.[27] | Tryptophan depletion | 12 (12/0) | (21-31) | No |
| Silva et al.[28] | Nefazodone | 12 (2/10) | $\bar{X}$ (SD) = 24.1 (3.7) | VAMS-Anxiety |
| De-Paris et al.[7] | Gabapentin | 11 (11/0) | (17-30) | VAMS-Anxiety, SBP, HR |
| Garcia-Leal et al.[29] | Panic patients | 17 (9/8) | $\bar{X}$ (SD) = 34.7(12.3) | VAMS-Anxiety |
| Parente et al.[30] | Panic patients | 16 (9/7) | $\bar{X}$ (SD) = 34.5(3.18) | VAMS-Anxiety, SBP, HR |
| Garcia-Leal et al.[31] | Escitalopram | 12 (12/0) | $\bar{X}$ (SD) = 24.1(0.89) | VAMS-Anxiety, SBP, HR |
| Bergamacsh et al.[32] | Cannabidiol - Social anxiety disorder | 12 (6/6) | $\bar{X}$ (SD) = 22.9(2.4) | VAMS-Anxiety, SBP, HR |

HR = heart rate; F = female; M = male; SBP = systolic blood pressure; SPST = Simulated Public Speaking Task; STROOP = Stroop Color Word Test; VAMS = Visual Analog Mood Scale; $\bar{X}$ (SD) = mean (standard deviation).
* Subjects with medium trait anxiety.

The difference between VAMS-Anxiety, HR, SBP and DBP at baseline and at each point in the study were calculated for each group, and mean delta values are presented in Figure 3. The rmANOVA showed a significant group by time interaction in VAMS-Anxiety ($F_{4,90} = 8.34$; $p \leqslant 0.001$), HR ($F_{4,90} = 23.19$; $p \leqslant 0.001$), SBP ($F_{4,90} = 32.37$; $p \leqslant 0.001$) and DBP ($F_{4,90} = 13.66$; $p \leqslant 0.001$). Results of the ANOVA indicated significant group differences between all four measures taken during the speech. The VAMS-Anxiety scores in the real-world group were significantly higher than those in the control group and in the SPST group (Bonferroni, $p \leqslant 0.001$ and $p = 0.035$, respectively). The VAMS-Anxiety scores in the SPST group trended toward being significantly higher than those in the control group (Bonferroni, $p = 0.08$). The physiological measures (HR, SBP, and DBP) of the real-world group were significantly higher than those of the control and SPST groups (Bonferoni, $p < 0.001$), while the SPST group did not differ significantly from the control group.

## Discussion

The meta-analysis of SPST studies using the McNair protocol confirmed the hypothesis derived from a non-systematic analysis of the literature. Both sources of evidence suggested that SPST induced a significant

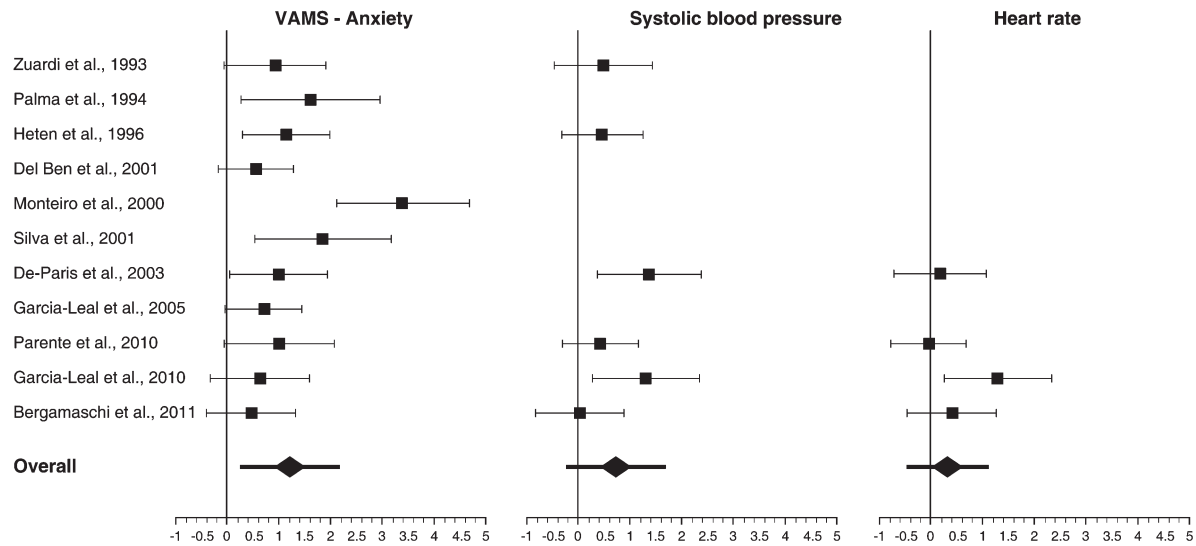



**Figure 2** Effect size and 95% confidence interval of the McNair et al.[4] simulated public speaking task on the self-rated anxiety (VAMS-Anxiety), systolic blood pressure, and heart rate of healthy volunteers. Each measure compares baseline and speech performance measures. VAMS = Visual Analog Mood Scale.

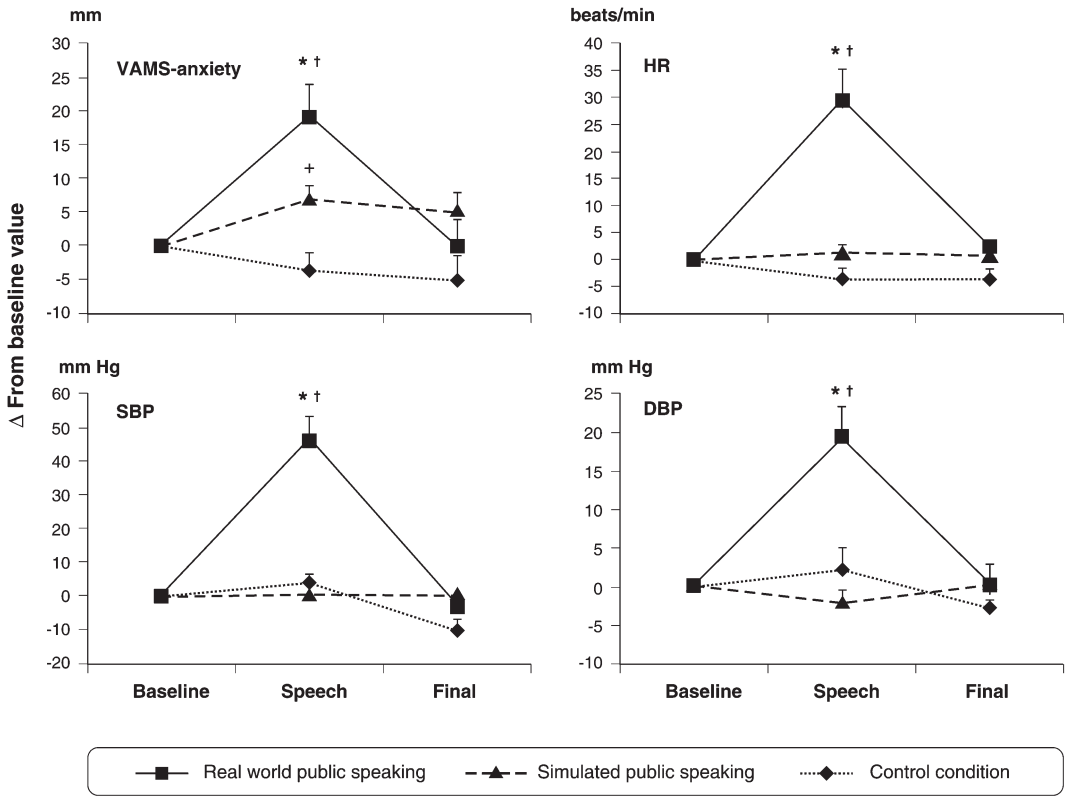



**Figure 3** Psychological and physiological measures of anxiety in healthy volunteers submitted to real world public speaking, simulated public speaking, and a control condition. Plots show the mean change from baseline measures to those made during (Speech) and after the speech (Final) ± SEM. Significant differences between control and simulated public speaking groups are represented by * and †, respectively. DBP = diastolic blood pressure; HR = heart rate; SBP = systolic blood pressure; SEM = standard error of mean; VAMS = Visual Analog Mood Scale.

increase in subjective anxiety, measured by the VAMS-Anxiety factor, without an accompanying increase in SBP and HR. The lower sensitivity of physiological measures as compared to subjective self-assessment has been observed in previous pharmacological challenge studies that used the SPST.[8,29] Moreover, the discrepancy between the effect of the experimental procedure on self-reported anxiety and physiological responses has been reported in patients with anxiety disorders such as panic disorder[33] and social phobia.[34]

The low sensitivity of physiological measures may be an artifact of the type of anxiety generated by the experimental procedure. In fact, the procedures generally used to induce experimental anxiety may not adequately represent real world situations.[34]

To test the hypothesis that physiological measures change more in real world public speaking than in a simulated situation, the present study compared the responses of healthy volunteers to both procedures. The results confirmed the hypothesis that only subjects submitted to real-world speaking demonstrated higher HR, SBP, and DBP levels than the subjects in the control condition. Physiological measures were also higher in the real-world condition than in the SPST condition. In the SPST group, only self-reported anxiety trended toward being significantly higher than in the control condition.

The increased cardiovascular response to real world public speaking as compared to simulated public speaking has been previously observed.[9] Similarly, a meta-analytic study of cortisol response to acute stress showed that the presence of an evaluative audience is a stronger predictor of increased cortisol levels following public speaking than the recorded videotape.[10] These results suggest that the physical presence of an evaluative audience has a greater impact on physiological responses than a potential future evaluation (SPST).

Several reasons could explain the differences in physiological response between real-world and simulated public speaking. It may require more effort to speak before an audience, there may be differences in the appraisal of situations in which individuals are observed in real time, and the presence of others in a context of potential failure could induce more shame.[10]

In conclusion, the present study suggested that real world public speaking could be a more adequate way to induce anxiety in experimental studies than simulated public speaking. The difficulty in securing a standardized audience[13] for this type of task could be overcome by using the protocol suggested in this study, in which all subjects participate in the same experimental session and take turns as speakers and members of the audience.

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## Disclosure

The authors report no conflicts of interest.

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