Relaxation before Debriefing during High-fidelity Simulation Improves Memory Retention of Residents at Three Months

A Prospective Randomized Controlled Study

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ABSTRACT

Background: High-fidelity simulation is known to improve participant learning and behavioral performance. Simulation scenarios generate stress that affects memory retention and may impact future performance. The authors hypothesized that more participants would recall three or more critical key messages at three months when a relaxation break was performed before debriefing of critical event scenarios.

Methods: Each resident actively participated in one scenario and observed another. Residents were randomized in two parallel-arms. The intervention was a 5-min standardized relaxation break immediately before debriefing; controls had no break before debriefing. Five scenario-specific messages were read aloud by instructors during debriefings. Residents were asked by telephone three months later to recall the five messages from their two scenarios, and were scored for each scenario by blinded investigators. The primary endpoint was the number of residents participating actively who recalled three or more messages. Secondary endpoints included: number of residents observing who recalled three or more messages, anxiety level, and debriefing quality.

Results: In total, 149 residents were randomized and included. There were 52 of 73 (71%) residents participating actively who recalled three or more messages at three months in the intervention group *versus* 35 of 76 (46%) among controls (difference: 25% [95% CI, 10 to 40%], $P = 0.004$). No significant difference was found between groups for observers, anxiety or debriefing quality.

Conclusions: There was an additional 25% of active participants who recalled the critical messages at three months when a relaxation break was performed before debriefing of scenarios. Benefits of relaxation to enhance learning should be considered for medical education. **(ANESTHESIOLOGY 2018; 128:638-49)**

MEDICAL education during intensive care and anesthesiology residency focuses on trainees developing the requisite skills needed to independently provide safe, effective, efficient, and evidence-based care.[1–3] High-fidelity simulation (HFS) is often embraced as an integral part of a longitudinal training curriculum and aims to accomplish part of this objective. HFS has been demonstrated to be effective in improving knowledge retention, with associated improvement in participant behavior and performance during the simulation as well as improved transfer of performance to actual clinical practice.[4–6]

For certain learning objectives, realism enhances the pedagogical value of HFS; but may also increase stress.[7,8] Stress has classically been associated with improvements in cognitive performance and memory improvement,[9] but, beyond a certain threshold, which varies among individuals, stress may also impair information retention.[10–12]

What We Already Know about This Topic

- Simulation in anesthesiology is useful for learning and improving behavioral performance
- Simulation debriefing traditionally consists of a participant reaction phase, an analysis phase, and a summary phase
- Simulation scenarios can generate stress that may impair information retention

What This Article Tells Us That Is New

- This investigation tested whether residents in a simulation would better recall critical key messages at three months when a relaxation break occurred before debriefing
- More residents (71 *vs*. 46%) recalled three or more messages at three months when there was a relaxation break compared with controls
- Results suggest that relaxation as a cognitive technique may enhance learning

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HFS debriefing traditionally starts with a "reactions phase" to enable cognitive defusion and help participants express themselves.[13] After the reactions phase, the debriefing continues with a formative assessment, the "analysis phase." The debriefing is then concluded by a "summary phase," designed to ensure better memory encoding and consolidation of critical key messages (CKM) with personal improvement tips.[14,15]

The literature on HFS provides evidence that supports the effectiveness of debriefing as a tool to improve participant knowledge acquisition.[16] Expert recommendations advise starting debriefing immediately after the scenario,[14] yet no study has investigated the validity of this assumption, and the literature does not provide a clear standard for the most effective debriefing model.[16,17] Interestingly, conversational relaxation with progressive muscle relaxation and mindful breathing has shown efficacy in reducing stress levels,[18–20] enhancing both working and long-term memory retention.[21,22] Therefore, the hypothesis was that during HFS, residents would benefit from a collective and standardized relaxation break before debriefing. While the goal of simulated-based educational curriculum is the transfer of performance to clinical practice, it is difficult to measure objectively. Memory retention however represents an intermediate endpoint that is more straightforward and amenable to measurement. If relaxation before debriefing during HFS leads to better retention of CKM months later, it is reasonable to expect that subjects will likely perform better in simulated or real critical situations. To investigate this, we first conducted a study to explore the association between a relaxation break and the number of scenario-specific CKM recalled at three months by residents after a simulated critical event in HFS.

Materials and Methods

Design

The study protocol was preregistered on May 20, 2015 on clinicaltrials.gov (NCT02470130). The study obtained approval from the Hospices Civils de Lyon institutional ethics committee (September 2, 2014). This prospective randomized (1:1) controlled study with two parallel arms and a hypothesis of superiority, was conducted at the Lyon teaching center for simulation in health care (Centre Lyonnais d'Enseignement par Simulation en Santé [CLESS]) at the Claude Bernard Lyon 1 University (Lyon, France). Enrolled residents gave their oral individual informed consent after they received general information about the study (including that they could be contacted by telephone or email if needed). This study followed the recommendations of the International Committee of Medical Journal Editors and the results were reported using the Consolidated Standards of Reporting Trials (CONSORT) guidelines.[23]

Population and Simulation Setting

This study involved all residents participating in HFS sessions in the CLESS during the 2014 to 2015 academic year. These HFS sessions were part of their resident educational program and were not formally evaluated. No exclusion criterion was applied. HFS sessions were organized by postgraduate year as repetitive sessions of four to five hours. Residents of the same specialty and postgraduate year were divided into groups of three to eight residents per HFS session. Two similar HFS sessions were organized each simulation day with two different groups of residents from the same specialty and year of training. One or two residents participated actively in each scenario. Three to five different scenarios ran consecutively during each HFS session so that each resident participated actively only once. HFS sessions followed the usual sequences of briefing, scenario, and debriefing for each scenario. Residents not actively participating in the scenario observed live video transmission from an adjacent debriefing room. SimMan Essential and SimBaby manikins (Laerdal Medical AS, Norway) were used. Scenarios dealt with crisis situations in the emergency department, operating room, intensive care unit or intrahospital patient transport. They were adapted to specialty and training level of the residents. Immediately after each scenario, a structured debriefing took place with all residents (active participants and observers). Two instructors facilitated debriefings. All instructors were anesthetists, intensivists or pediatricians who were certified in medical simulation instruction or had at least two years of simulation instructor experience. For a given scenario, the same two instructors facilitated all debriefings. Debriefings focused on individual performance as well as technical/medical aspects of the scenario and lasted approximately 30 min. Debriefings employed plus/delta and Promoting Excellence and Reflective Learning in Simulation (PEARLS) models. A figure presenting the debriefing framework after the Simulation-Population, Intervention, Comparator, Outcome (Sim-PICO) model is provided in appendix 1.[24] A simulation technician provided technical support.

Intervention

Residents assigned to the intervention group (RELAX) had a standardized collective relaxation break between the scenario and debriefing which took place in the debriefing room. The

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same instructor (M.L.) guided each relaxation break, which consisted of a standard text read slowly in a peaceful tone of voice over five minutes (appendix 2). All residents (active participants and observers) and instructors were invited to close their eyes, to breathe quietly, and to relax while listening to the text. At the conclusion of the relaxation break the debriefing was started. For residents assigned to the control group, the debriefing started immediately after the end of the scenario.

Experimental Protocol

Scenarios and order of scenarios were predetermined by instructors before the HFS session and were the same for morning and afternoon sessions. The intervention was preallocated either to the odd numbered scenarios or to the even numbered scenarios alternatively. The instructors were the same in RELAX and control groups for the same scenario. Blocked and stratified randomization by specialty, postgraduate year and simulated scenario was performed. Randomization sequence assignment (1:1) was performed before the start of the HFS session by randomly picking concealed names to assign them to the order of scenarios in which they would actively participate. The instructor performing the randomization was blinded to group allocation. Residents were not informed of the group allocation and scenario assignment before the scenario started. Each resident participated to two scenarios: one as an active participant and another one as an observer (fig. 1). Each scenario had five preestablished specific CKM as clear attitudes or treatments that would clinically solve the critical situation (the complete list is provided in Supplemental Digital Content, http://links.lww.com/ALN/B599). These five CKM were chosen by consensus between local experts, writers and facilitators of the scenario, and were given orally to residents by the main instructor facilitating debriefing at the very end of the debriefing.

Questionnaires and Data

Questionnaires and data collected are presented in a timeline in figure 2. Residents were asked to complete a demographic questionnaire, the validated French translation of the State-Trait Anxiety Inventory (STAI) form before and at the conclusion of debriefing (STAI-State [STAI-S]: from 20 to 80 points)[25,26] and iterative Visual Analog Scale for Anxiety (VAS-A: subsequently converted to a 0 to 100 mm numerical scale).[27] The duration of debriefing was recorded but was not time-restricted. The Debriefing Assessment for Simulation in Healthcare (DASH from 7 to 42 points) questionnaire has yet to be widely explored in the literature; however, it is a validated tool to assess the quality of the simulation session with a focus on the debriefing.[28,29] The version of DASH used in this study was translated locally into French because no official version was available at the time of study implementation. The DASH was completed by both active participants and observers of the scenario (DASH-Student) at the conclusion of debriefing.[30] The DASH-Instructor evaluation was scored by the instructor who facilitated the debriefing and the DASH-Rater evaluation was scored by a peer observer instructor at the conclusion of each debriefing. The use of DASH evaluation is standard practice at the investigation simulation center, but for completeness a formal review of the DASH rating system was provided to instructors before the study.

The STAI-Trait form (STAI-T: from 20 to 80 points) and the validated French translation of the Fear of Negative Evaluation (FNE) scale (from 0 to 30 points) were emailed to residents two weeks later.[31,32]

Three months after the HFS session, one investigator (M.L.) who was blinded to group allocation, contacted residents by telephone without any previous notice. If residents were unavailable or busy at the start of the phone call, the investigator asked to call back. The investigator read a preestablished questionnaire (appendix 3). Residents were invited to recall the five CKM of the scenario in which they had participated actively and that they had observed. The investigator transcribed responses on a word-for-word basis and read back the response to confirm the accuracy of the transcription. At the end of the interview, residents were

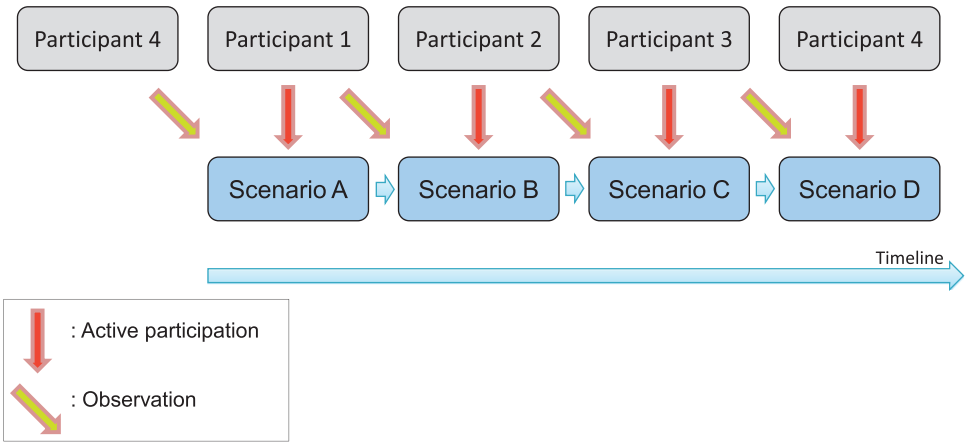

Fig. 1. Timeline and participation of residents: active participants of a scenario and observers of another scenario.

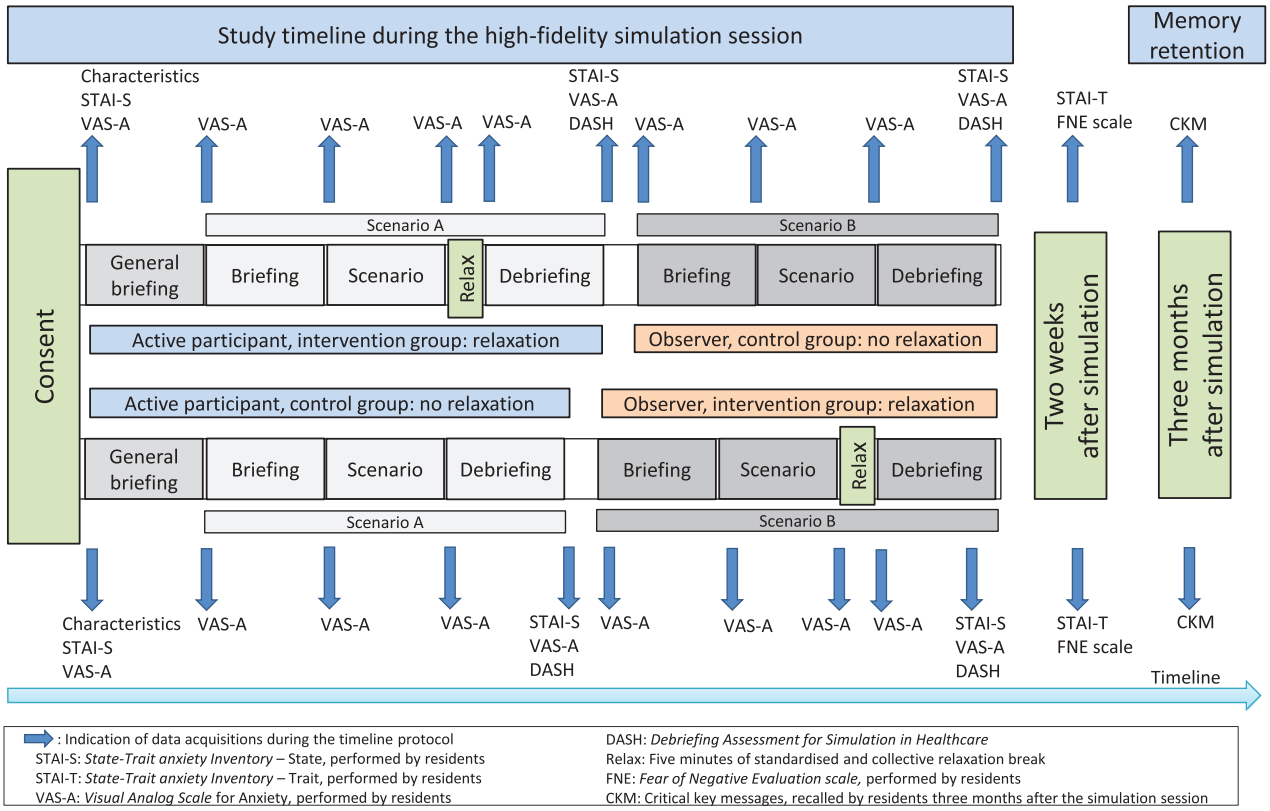

Fig. 2. Protocol timeline.

instructed to maintain the confidentiality of interview content. Subsequently, two investigators (M.L. and J.-N.E., who were also instructors), blinded to group allocation, independently attributed zero or one point for each CKM recalled (binary; yes or no) for each resident and for each scenario (the one with resident as active participant and the one with resident as observer). For each scenario and each resident, the two total scores from each investigator (from zero to five points based on the CKM recalled) were then compared. If the difference between the two scores was less or equal to one point, the mean of the two scores was recorded. If the difference between the scores was greater than one point, a third blinded instructor scored the CKM recalled and the mean of the scores of the three raters was recorded.

Endpoints

The scale of CKM recalled was coded from zero to five, however, the plan of analysis was *a priori* designated to examine the number of residents with three or more CKM recalled. The primary endpoint was the number of residents participating actively who recalled three or more messages out of the five at three months. Secondary endpoints were: the number of residents observing who recalled three or more messages out of the five at three months, the mean number of CKM recalled at three months by residents (as active participants or observers), the level of anxiety assessed by VAS-A, STAI-S, and the quality of debriefing rated by the DASH.

Statistical Analysis

Considering that one-third of residents would recall at least three CKM in the control group (based on past experience), and the assumption that the RELAX group would have twice as many residents recalling three CKM as the control group, a sample size of 64 residents (32 per group) was calculated *a priori* to reach a power of 80% with a two-sided type I error probability of 0.05. However, in order to obtain a representative cohort from each year of residency, all residents scheduled for HFS were invited to be included during the whole academic year. Statistical analysis was performed on an intention-to-treat basis. Categorical variables (including the primary endpoint) were presented using absolute and relative frequencies and compared using the chi-square test or Fisher's exact test as appropriate. Continuous variables (secondary endpoints) were described using mean (SD) or median (25th to 75th) and compared using Student's *t* test or Mann-Whitney as appropriate. Difference estimates with 95% CIs are provided. Interrater agreement (95% CI) with weighted Kappa was used to assess the reliability of the two investigators' CKM scores for each participant and for each scenario. In order to identify factors associated with at least three CKM recalled, a multilevel

logistic regression with the generalized estimating equation method was planned *a priori* to account for residents being both participants and observers. The main predictor was built from a combination of variables: active participant of scenario *versus* observer of scenario, and relaxation break *versus* no relaxation break. To control for potential confounders, adjustment was performed on sex and year of residency (residents' experience from 1 to 5 yr). The results were presented as adjusted odds ratios (OR) with corresponding 95% CI. All tests were two-tailed, and $P < 0.05$ was considered as statistically significant. Data analyses were performed using Statistical Analysis System (version 9.3; SAS Institute Inc., USA).

Results

All residents who met the inclusion criteria gave consent to participate in the study. A total of 149 residents were randomized from October 2014 to January 2016 (appendix 4). There were 126 (85%) anesthesiology and critical care residents, and 23 (15%) pediatric critical care residents. For active participants, 73 were allocated to the RELAX group and 76 to the control group. Two residents were not present for the totality of debriefing for the observed scenario (they completed the process as active participants). A total of 139 residents completed and returned the STAI-T and FNE questionnaires.

Participant characteristics and outcome data for active participants and observers are presented in table 1 and table 2. All included residents were called at three months for interview. One resident could not be reached. Two questionnaires were lost in transport between the offices of the investigators who scored CKM recall, and the non-validated scores were therefore not considered for analysis.

The inter-rater agreement between the two investigators for CKM ratings was good for active participants (95% CI, 0.606 to 0.771; $P = 0.689$) and for observers (95% CI, 0.686 to 0.835; $P = 0.761$). The two investigators found 16 differences of more than one point in CKM scoring (nine in the active participant group and seven in the observer group).

Endpoints

For scenarios in which residents participated actively, there was an additional 25% of residents as active participants in the RELAX group who recalled three or more out of the five CKM (N = 52, 71%) as compared with the control group (N = 35, 46%; difference: 25% [95% CI, 10 to 40%], $P = 0.004$) at three months (table 2). The mean number of recalled CKM was nearly 13% percentage points greater in the RELAX group (3 ± 1) than in the control group (3 ± 1); difference: 0.4 (95% CI, 0 to 1), $P = 0.009$). Five residents (7%) in the RELAX group *versus* one (1%) in the control group recalled all CKM ($P = 0.114$). There was no significant difference between RELAX and control groups with regards to the mean end of debriefing STAI-S score (respectively 35 ± 10 *vs.* 34 ± 7; difference: 0.4 [95% CI, –2 to 3], $P = 0.752$), the mean end of the debriefing VAS-A (respectively 17 ± 20 *vs.* 16 ± 15; difference: 0.3 [95% CI, –5 to 7], $P = 0.294$), and the mean DASH-Student scores (respectively 38 ± 3 *vs.* 38 ± 2; difference: –0.6 [95% CI, –1 to 1], $P = 0.213$).

For scenarios that were observed by residents, there was no significant difference between RELAX and control groups with regards to the number of residents who recalled three or more CKM (respectively 43 ± 58% *vs.* 35 ± 47%; difference: 11% [95% CI, –4 to 27%], $P = 0.151$). The mean number of recalled CKM was

Table 1. Participant Characteristics: RELAX and Control Groups for Active Participants and Observers

	Active Participants		Observers	
	RELAX (N = 73)	Control (N = 76)	RELAX (N = 74)	Control (N = 75)
Characteristics data				
Female, N (%)	39 (53%)	39 (51%)	38 (51%)	40 (53%)
Age, yr	27 [26–28]	27 [26–28]	27 [26–28]	27 [26–28]
Psychometric data at baseline				
FNE, points	17 (7)	17 (6)	17 (6)	17 (7)
STAI-T, points	42 (8)	41 (8)	42 (8)	41 (8)
Psychometric data before intervention*				
Initial STAI-S, points	41 (10)	42 (10)	41 (10)	42 (10)
Initial VAS-A, mm	43 (25)	47 (24)	47 (24)	44 (25)
Before briefing VAS-A, mm	56 (28)	59 (25)	13 [4–27]	9 [1–28]
Before scenario VAS-A, mm	61 (26)	64 (23)	15 [6–40]	9 [1–40]
Post scenario VAS-A, mm	43 (26)	45 (22)	19 [4–45]	11 [2–36]

Values are expressed as n (%), mean (SD), or median [25th-75th] as appropriate.

*The intervention is a relaxation break between the end of the scenario and the debriefing in the RELAX group or no relaxation break in the control group.

FNE = Fear of Negative Evaluation Scale (from 0: no FNE to 30 points: FNE maximal); RELAX = residents assigned to the intervention group; STAI = State-Trait Anxiety Inventory (from 20: very low to 80 points: very high); STAI-S = STAI State; STAI-T = STAI Trait; VAS-A = Visual analog scale for anxiety (from 0: no anxiety to 100 mm: maximal anxiety).

Table 2. Outcome Data: RELAX and Control Groups for Active Participants and Observers

	Active Participants				Observers			
	RELAX (N = 73)	Control (N = 76)	*P* Value	Difference (95% CI)	RELAX (N = 74)	Control (n = 75)	*P* Value	Difference (95% CI)
Psychometrics data after intervention*								
Postrelaxation VAS-A, mm	17 [7–32]	NA	NA	NA	4 [1–19]	NA	NA	NA
Postdebriefing VAS-A, mm	17 (20)	16 (15)	0.294	0.3 (–5 to 7)	16 (21)	18 (26)	0.607	–2.2 (–10 to 6)
End of debriefing STAI-S, points	35 (10)	34 (7)	0.752	0.4 (–2 to 3)	35 (10)	35 (12)	0.751	–0.5 (–4 to 3)
Debriefing								
Debriefing duration, min	27 (8)	26 (6)	0.385	1.0 (–1 to 3)	27 (8)	26 (6)	0.385	1.0 (–1 to 3)
DASH-Student, points	38 (3)	38 (2)	0.213	–0.6 (–1 to 1)	38 (3)	38 (3)	0.416	0.4 (–1 to 1)
DASH-Instructor, points	32 (4)	33 (3)	0.391	–0.2 (–2 to 0)	32 (4)	33 (3)	0.454	0.4 (–2 to 0)
DASH-Rater, points	36 (2)	36 (2)	0.575	–0.5 (–1 to 1)	36 (2)	36 (2)	0.279	0.4 (–1 to 1)
Evaluation at 3 months								
Residents with ≥ 3 CKM recalled	52 (71%)	35 (46%)	0.004	25% (10 to 40)	43 (58%)	35 (47%)	0.151	11% (–4 to 27)
Mean number of CKM recalled	3 (1)	3 (1)	0.009	0.4 (0 to 1)	3 (1)	2 (1)	0.042	0.4 (0 to 1)

Values are expressed as n (%), mean (SD), or median [25th-75th] as appropriate.

*The intervention is a relaxation break between the end of the scenario and the debriefing in the RELAX group or no relaxation break in the control group.

CKM = Critical key messages; DASH = Debriefing Assessment for Simulation in Healthcare (from 7: poor quality to 42 points: maximum quality); NA = not applicable; RELAX = residents assigned to the intervention group; STAI = State-Trait Anxiety Inventory (from 20: very low to 80 points: very high); STAI-S = STAI State; VAS-A = Visual analog scale for anxiety (from 0: no anxiety to 100 mm: maximal anxiety).

nearly 20 percentage points greater in the RELAX group (3 ± 1) than in the control group (2 ± 1; difference: 0.4 [95% CI, 0 to 1], $P = 0.042$). Six residents (8%) in the RELAX *versus* one (1%) in the control group recalled all CKM ($P = 0.059$). There was no significant difference between the RELAX and control groups with regards to the mean end of debriefing STAI-S (respectively 35 ± 10 *vs.* 35 ± 12; difference: –0.5 [95% CI, –4 to 3], $P = 0.751$), the mean end of the debriefing VAS-A (respectively 16 ± 21 *vs.* 18 ± 26; difference: –2.2 [95% CI, –10 to 6], $P = 0.607$), and the mean DASH-Student scores (respectively 38 ± 3 *vs.* 38 ± 3; difference: 0.4 [95% CI, –1 to 1], $P = 0.416$; table 2).

Multilevel logistic regression analysis found that being an active participant of the scenario in the RELAX group (OR = 3.0 [95% CI, 1.5 to 6.2], $P = 0.003$), being male (OR = 2.2 [95% CI, 1.4 to 3.7], $P = 0.002$) were independently and positively associated with three or more CKM recalled at three months. However, being in the fourth and the fifth year of residency (respectively OR = 0.4 [95% CI, 0.2 to 1.0], $P = 0.038$; OR = 0.4 [95% CI, 0.1 to 1.0], $P = 0.050$) was independently and negatively associated with three or more CKM recalled at three months (table 3).

Discussion

Few publications have reported the effect of relaxation on cognitive performance, and to the best of our knowledge, no study has investigated its effect on behavioral performance.[18,21,22,33,34] HFS generates anxiety that may impair selective attention as well as working and delayed memory recall, which are major cognitive functions involved in long-term memory retention.[11,35,36] Therefore, if anxiety persists during debriefing, it may disturb learners from the informative content of debriefing and favor retention of the perceived specific causes of anxiety rather than the specific CKM of the scenario.[37]

The current study found that there was an additional 25% (95% CI, 10 to 40%, $P = 0.004$) of active participants in HFS scenarios who recalled at least three out of five CKM at three months when a collective standardized relaxation break was performed before debriefing. Relaxation positively affects memory in different ways. First, relaxation may condition participants to take full advantage of the debriefing session by enhancing their cognitive performance while reducing their level of stress.[38] Second, working memory and storage processes for long-term memory consolidation have been shown to improve with relaxation independent of stress context.[21,22] Third, relaxation may help anchor newly acquired data during the scenario. This positive postlearning effect on memory consolidation is supported by a study that found significant improvement in incidental long-term memory in healthy subjects when a single relaxation session was performed.[22] Relaxation has been proven to increase ascending and descending parasympathetic nervous system activity,[39] which has been associated with enhancement of memory retention.[40]

However, there was no difference between observers with or without relaxation break in the number of residents who recalled three or more CKM at three months. Interestingly, there was a lower iterative VAS-A measured during the observed scenario that indicates a difference in anxiety level between active participants and observers. Therefore, the lack of relaxation effect for observers is likely to be due to a decreased anxiety level experienced by observers. One may rationalize that relaxation

is more effective to increase the recall of CKM for participants who are involved in a more stressful event.

The logistic regression found that a relaxation break occurring just after the simulated scenario was independently associated with better recall of the CKM of the scenario at three months for active participants. The logistic regression also found that male sex was associated with increased recall of three or more CKM. Such a difference in memory retention between sexes during periods of anxiety is supported by psychologic,[41] neurobiologic,[42] and functional neuroimaging studies.[42,43] However, this was not an observation intentionally investigated in the current study, and one might be more interested by implementation of external factors that will enhance learning. The logistic regression also found that the farther along in the curriculum residents were, the less likely they were to recall the CKM appropriately. This observation argues for simulation learning early in the residency educational program, and substantiates a recent report that found younger board-certified anesthesiologists received higher performance ratings than older ones during HFS.[44] To explain and to protect from the causes of such differences may be of profound interest for program directors, simulation experts, and for the future of training assessments.

Table 3. Factors Independently Associated with Three or More Critical Key Messages Recalled by Residents

	Odds Ratio (95% CI)	*P* Value
Active participant of scenario without relaxation break	—	—
Active participant of scenario with a relaxation break	3.0 (1.5 to 6.2)	0.003
Observer of scenario without relaxation break	1.0 (0.5 to 2.0)	0.994
Observer of scenario with a relaxation break	1.7 (0.9 to 3.3)	0.100
Male sex	2.2 (1.4 to 3.7)	0.002
First year of residency	—	—
Second year of residency	0.9 (0.4 to 2.2)	0.881
Third year of residency	0.5 (0.2 to 1.3)	0.160
Fourth year of residency	0.4 (0.2 to 1.0)	0.038
Fifth year of residency	0.4 (0.1 to 1.0)	0.050

Implications

The debriefing is considered to be the cornerstone of HFS. It should be structured and supported by psychologic approaches for promoting effective learning.[14,45–47] Debriefing usually starts with a reactions phase in which facilitators are supposed to help participants to reflect on and verbalize their emotions. This process is considered essential to prepare participants for debriefing discussions, however, it is not always an easy task for debriefing facilitators.[15] The literature recommends immediate debriefing after critical event scenarios, but formal personal reflection may justify a delay for a more efficient debriefing.[14] While not a substitute for a reactions phase, the relaxation break might prove to be an important adjunct to the debriefing, worthy of the additional five minutes per scenario to improve memory retention of critical actions.

Examples of CKM are presented in table 4 in order to highlight the importance of each individual CKM and the importance of coordination of the all five CKM to solve critical situations. The clinical importance of each individual CKM might vary depending on the scenario; however, it is important for residents to maximize recall of CKM. Although residents rarely recalled all CKM for a given scenario, the increased number of residents who recalled at least three CKM when a relaxation break was used before debriefing provides new evidence for the use of cognitive techniques to enhance participants' learning. It also suggests that it may be worth exploring the effect of using several cognitive techniques to help memory retention after HFS.

In a step toward investigation of the effect on performance, memory retention of objectives at three months was chosen as a first straightforward endpoint, and the results suggest that the use of relaxation as an adjunct cognitive technique for the enhancement of learning retention is promising. In addition to improving memory retention, incorporation of relaxation techniques into healthcare education may also help residents translate knowledge into clinical practice. At the investigation simulation center, collective relaxation is now routinely provided before the debriefing for stressful scenarios, when instructors suspect higher stress on participants and when requested by participants or instructors. While no data have been collected, our experience suggests other benefits not explored here.

Table 4. Examples of Two Scenarios with Their Synopsis and Their Five Critical Key Messages Delivered at the End of the Debriefing

Example Scenario A	Example Scenario B
A cardiopulmonary arrest caused by a sudden ventricular fibrillation occurring in the postanesthesia care unit.	A pediatric septic shock with purpuric meningitis arriving in the emergency department.
1. Start cardiopulmonary resuscitation	1. Diagnose the septic shock
2. Call for help	2. Insert an intravenous line (or intraosseous if needed)
3. Defibrillate	3. Administer intravenous fluid boluses
4. Switch performers for chest compressions every 2 min	4. Draw blood samples for blood culture
5. Administer intravenous bolus of 1 mg of epinephrine + 300 mg of amiodarone after the 3rd shock	5. Start intravenous antibiotics as soon as possible

For instance, some instructors now employ the relaxation break before debriefing of critical situations in the actual clinical setting.

Limitations

One important limitation of this study is that the relaxation break was not compared to a nonstandardized break, but it is also of note that the duration of the break was chosen arbitrarily. Additionally, no assessment of baseline factual knowledge, of performance during simulation, and of the individuals' ongoing learning environment was done before the intervention and before the phone call interview. While any of these factors might have affected CKM retention at three months, the randomization process most likely eliminated this bias, balancing groups with participants' associated factors. Moreover, there is no evidence in the literature that performance during simulation is correlated with memory retention, and it is of note that the objective of debriefing is to allow participants to maximize both retention and future performance, irrespective of performance during the simulation. The limit of the phone call interview to measure retention of factual information at three months should be acknowledged. This method has not been validated *a priori* as an assessment tool and it might be perceived as a time-pressure situational challenge, which can affect memory recall. Another limitation is that the study explored memory retention of factual information about clinical treatments or tasks to be managed in emergency situations. One cannot presume that the effects of relaxation will translate to retention of nontechnical skills or details of technical procedures learned during HFS. More generally, no difference in anxiety was observed between groups. It is possible that the anxiety variables do not accurately reflect the specific stressors addressed by relaxation. Another explanation may be that the relaxation effect *per se* is affecting other pathways for memory retention not explored here. No biologic (salivary cortisol and alpha amylase) or hemodynamic data (heart rate variability, blood pressure, or electrodermal activity) was collected. Recent studies have highlighted large intra-individual variations of the autonomic nervous system activation and differences between professions.[48,49]

Future Directions

Further studies are warranted to confirm the effect of relaxation *per se*, to explore the optimal time-effectiveness ratio of a relaxation break during HFS, and to quantify the effect of relaxation on physical and psychometric parameters during simulation. Subsequent modification of the reactions phase and exploration of the relaxation effect in real clinical settings on individual and team performance might be of interest for future investigations.

Conclusions

The relaxation break occurring just after active participation in a simulated critical event scenario is independently associated with better recall of the scenario's critical key messages at three months. The benefits of relaxation as a cognitive technique to enhance the learning should be considered for medical education and should be investigated further to evaluate potential impact on posttraining clinical performance.

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Competing Interests

The authors declare no competing interests.

Reproducible Science

Full protocol available at: marclilot@hotmail.com. Raw data available at: marclilot@hotmail.com.

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Appendix 1

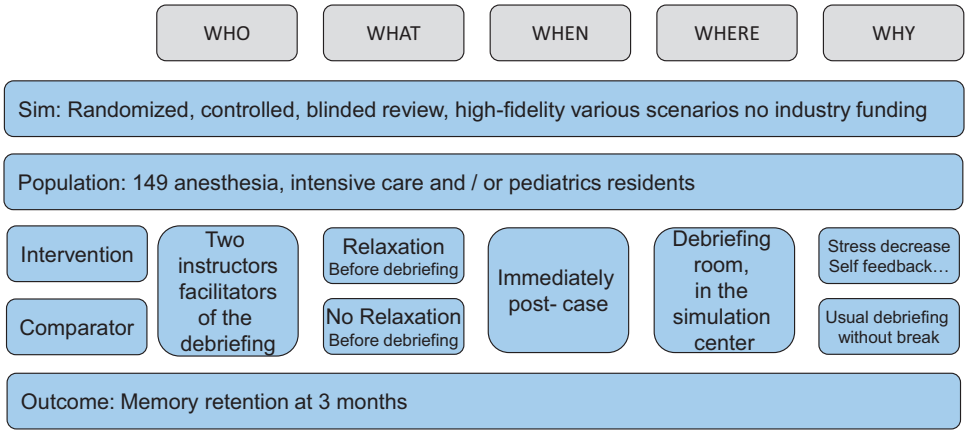


Fig. A1. Debriefing framework after the Simulation-Population, Intervention, Comparator, Outcome (Sim-PICO) model.[24]

Appendix 2: Relaxation Text

Text for conversational relaxation read aloud to the group:

"We are all going to spend 5 min in silence so that we can relax before starting the debriefing. Slowly and gently I am going to ask you to do the actions that I propose. Just allow yourselves to be guided by the sound of my voice, only my voice that will be guiding you during these 5 min. Are you all ready? ... Good …

First sit down comfortably on a chair and once you are comfortably settled, close your eyes, very good…

Your eyes are closed and you are now going to relax your closed eyelids, first the right side, then the left side, very good. Now you are relaxing your face starting with the mouth, and the jaw muscles. Let your face relax slowly, continue while letting your cheek muscles relax, and your cheekbones, and now feel the muscles in your forehead, and then your chin, relax.

Let your hands become loose, relax the muscles of your hands, the lower part of your arms. Now feel your elbows relaxing, your arms, and now relax your shoulders, on the right hand side, and the left hand side, slowly. Now feel the muscles of your neck relaxing.

And now, let yourself imagine a place that you like very much, a place where you know you can rest, a peaceful place, special, a place where you feel good, and safe. Slowly describe each item in this place, appreciate the tiniest details which make this place one that you like to be, take the time to linger in this restful place…

You are feeling so good, you are now concentrating on your breathing, slowly and peacefully you are breathing in and then breathing out. You feel the air peacefully filling your lungs and you are looking at yourself in this place that you like so much. You are breathing in and then breathing out. You are feeling so good and you are relaxing peacefully. Slowly relax your stomach muscles and continue to breathe gently, breathing in and then breathing out. You are continuing to imagine this place where you like to be and you are calmly observing this scene spread out before you. Take the time to feel how relaxed you are in this environment. You are breathing gently and you are feeling good.

Now, very gently you are going to raise your shoulders and your head, then slowly place your hands one after another on your stomach. Very good, and now you are quietly going to open your eyes, very good, and we are now going to restart the simulation session with the debriefing…"

Appendix 3: Assessment Questionnaire at Three Months

"Hello, I hope I'm not disturbing you?" Yes / No (if yes, call back later)

"Three months ago you took part in a high fidelity simulation session. Do you remember that?" Yes/No

"What type of scenario did you take part in?"_____.

"Can you recall the list of five key points that were mentioned at the end of the debriefing?" Yes/No

"Can you try and list them for me?"

Key targets:

5 targets, 1 point per target listed or explained:

Total: / 5

"On the same day you were also among the observers of a scenario dealing with_____. Do you remember this?" Yes/No

"Do you recall the five key points listed at the end of the debriefing?" Yes/No

"Could you try and list them for me, please?"

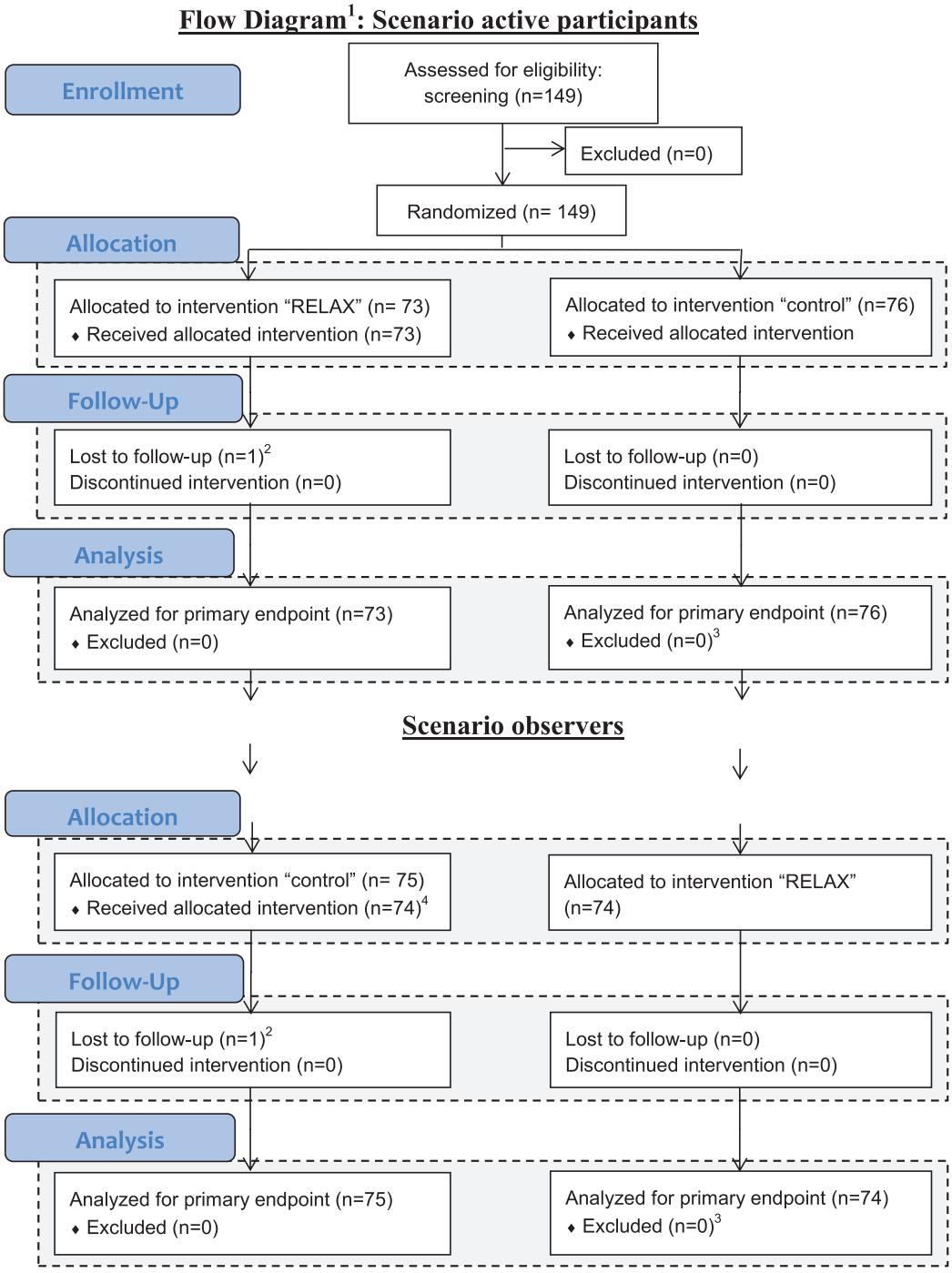
Key targets:

5 targets, 1 point per target listed or explained:

Total: / 5

Participant number: |__|__|__|__|

Appendix 4



1: Participants were active participant of one scenario and observers of another scenario successively during the simulation session. 2: Unable to contact at 3 months for telephone interview. 3: Two questionnaires were unable to be analyzed by investigators. 4: In total, two participants left before the allocated intervention.

Fig. A2. Flow diagram (based on Consolidated Standards of Reporting Trials [CONSORT] 2010[23]). RELAX = Residents assigned to the intervention group.

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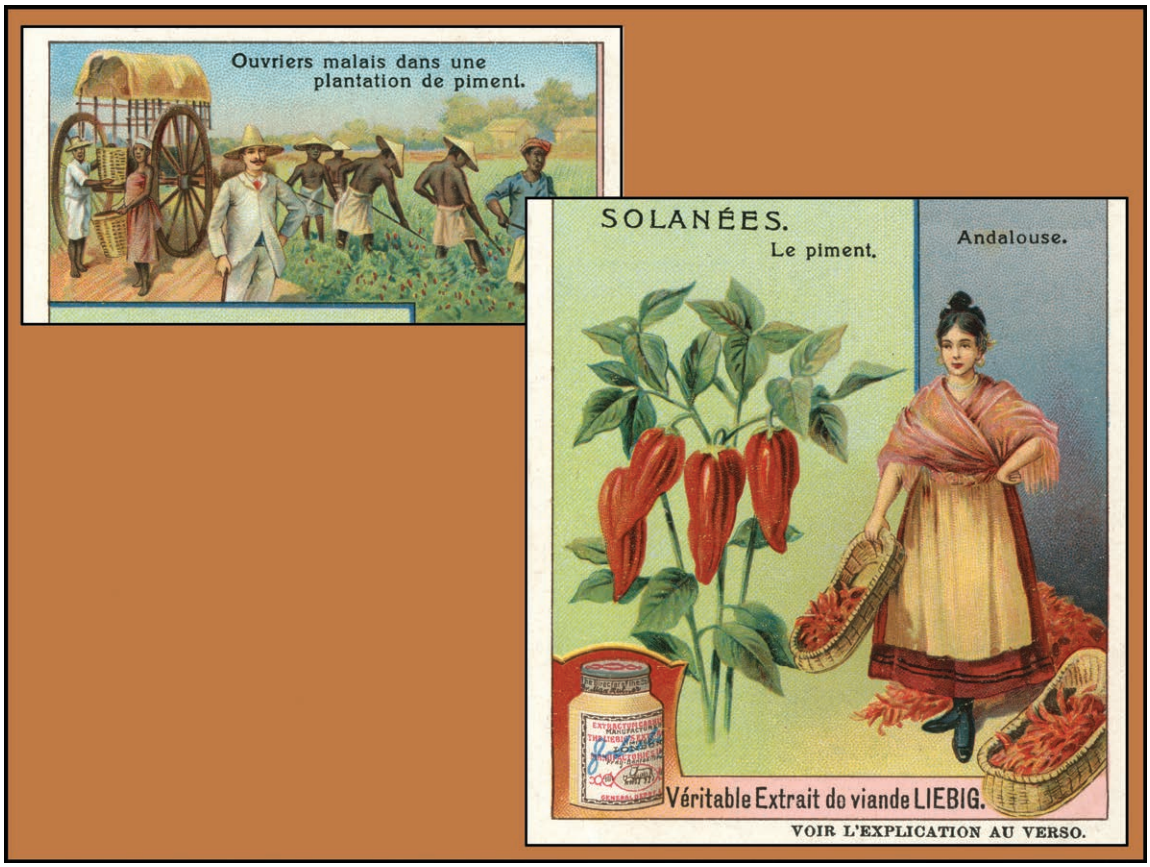
From Malaysia and Spain: The Liebig Company Peppers the World with Capsaicin



A discoverer of chloroform, Professor Justus von Liebig inspired the Liebig Extract of Beef Company, which collected many herbs and spices, including chili peppers from around the world. One of the company's French-language trade cards depicted Malaysian workers on a spice plantation (*upper left*) and a Spanish lady collecting peppers in her Andalusian basket (*lower right*). Not lost on the Liebig Company was the fact that many early liniments, including snake oils, frequently provided topical pain relief by including capsaicin-spiced ingredients, courtesy of the chili pepper. (Copyright © the American Society of Anesthesiologists' Wood Library-Museum of Anesthesiology.)

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