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ORIGINAL RESEARCH

An experimental study of an animal-assisted intervention in healthcare simulation to reduce negative affective arousal post-simulation

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ABSTRACT

Introduction:
In healthcare simulation, the appropriate level of stress produced through physiological and psychological arousal is necessary for effective experiential learning. While beneficial stress promotes learning, excessive stress inhibits learning. Animal Assisted Interventions may be a viable method to support learners experiencing excessive stress post-simulation. Animal Assisted Interventions have been used therapeutically with positive effects though there is an absence of research on Animal Assisted Interventions in healthcare simulation. This study investigates the efficacy of an Animal Assisted Intervention compared to an intervention control to reduce negative affective arousal post-simulation.

Methods:
Primary Care Paramedic, Animal Health, and Respiratory Therapy students were recruited for the study. The study utilized an experimental design. After a simulation, known to induce stress and potentially negative affective arousal, participants were randomly assigned to an Animal Assisted Activity with a Canine or to Diaphragmatic Breathing. Negative affective arousal was measured post-simulation and post-intervention using a Visual Analogue Scale.

Results:
Forty-five students participated in the study. Pre-intervention scores showed moderate levels of anxiety, stress and confusion. Both interventions led to a significant decrease in emotional affect. Participants in the Canine condition reported significantly lower levels of Anxiety compared to the Breathing Condition. Participants and facilitators expressed positive emotions related to the canine's presence.

Conclusions:
The presence of a canine was well received by all, and Animal Assisted Interventions can fit seamlessly into the post-simulation period to reduce anxiety after a simulation. Animal Assisted Activities may be best utilized for simulations known to be emotionally distressing and intensive.

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What this study adds:

- This study investigates previously unexamined Animal Assisted Interventions in healthcare simulation education.
- Canine-based Animal Assisted Intervention can be effective for reducing negative affect post-simulation.
- Implementing an Animal Assisted Intervention post-simulation can be done with minimal interruption to standard simulation operations.

Introduction

In healthcare simulation, emotional arousal and the induction of stress through "stressors", that is, variables that produce a stress response such as a challenging scenario, or time limitations can be important to create realism and foster authentic experiential learning [1,2]. Optimal levels of arousal, both physiological and psychological, produced by relevant stressors can promote beneficial outcomes. Stress that challenges and stretches the learner's abilities at an appropriate level to facilitate learning and skill development, providing a beneficial or healthy response and positive feelings, is known as eustress (good stress) [3]. Eustress aligns with the educational concept of a zone of proximal development and stimulating eustress during a simulation can be considered an outcome of good educational design [3]. Conversely, suboptimal arousal leads to an inadequate stress response while over-arousal can lead to an excessive stress response or distress. Inadequate or excessive arousal will be detrimental to learning [3–5]. When considering simulation and the demands of the simulation design, learning requirements and prior experiences if the stressors exceed an individual's cognitive, emotional or physical ability to handle the stressors, the excessive arousal can lead to distress and the inhibition of learning [3,4].

Modulating the appropriate levels of stressors can be challenging. Stress is subjective and context dependent, and individuals have variable adaptive performance-arousal curves [5,6]. Regardless of individual differences, particular simulations can be expected to induce greater or lower levels of eustress, stress or distress. For example, a simulation of a mass casualty incident could be expected to elicit high levels of stress and potentially lead to distress and a negative affective reaction, depending on the design of the simulation. Comparatively, for an advanced learner, a simulation focused on role clarification during a patient handoff may be well below a learner's ability and knowledge level leading to low arousal and potentially boredom. In either case, learning is not supported.

For simulations expected to be highly stressful, or whenever a learner is experiencing distress, it may be necessary to employ measures to de-escalate negative emotional affect to prevent potential psychological harm and ensure that learning can occur during post-simulation debriefing [2,7]. Typically, simulation centres employ processes and procedures to assist with negative psychological arousal, such as debriefing and external psychological support [8]. A novel method of simulation that could potentially support learners experiencing distress or excessive arousal post-simulation is Animal Assisted Intervention (AAI).

AAI is a broad term that describes purposeful animal–human interactions and encompasses Animal Assisted Activity (AAA), short-term interactions with an animal, and Animal Assisted Therapy (AAT), long-term interactions such as with a companion animal [9]. AAI is a well-developed treatment modality with increasing professionalization that includes accrediting organizations, training standards, scopes of practice and guidelines for practice [10–13]. Various animals have been used for AAI, though canines (kynotherapy) tend to be the most common[14]. Formalized AAI for therapeutic purposes can be dated to the 1960s and has grown over the last decade, with research indicating that AAI is safe and can positively impact many psychological and emotional outcomes [11,15]. AAI has been used as a treatment for a plethora of conditions, from post-traumatic stress disorder [16] to eating disorders[17] and has been investigated for various learning outcomes in the cognitive, emotional/behavioural and psychomotor domains, generally demonstrating positive outcomes[9,15,18,19]. AAIs are hypothesized to promote well-being and health through the interconnected pathways of the Bio-Psycho-Social model. The positive psychological and social effects of an AAI mitigate neurohormonal physiological responses to stress and anxiety, which cyclically reduces psychological distress leading to further downregulation of physiological responses [9]. Some of the positive benefits associated with AAIs, particularly for canines, may be a product of the touch and physical contact that is involved in the 'play' aspect of the interactions [19]; this is supported by findings that interactions with real animals are preferred to toy animals [15].

AAI may be particularly effective for simulation as the simulation is often conducted in group settings, and it may be challenging to identify who is experiencing excessive arousal; singling out an individual for intervention may not be appropriate; or it may be uncomfortable for a learner to be singled out for intervention. Additionally, an AAI can be conducted with minimal interference and interruption of the simulation process, fitting seamlessly into the post-simulation period before debriefing and without requiring learners to leave the learning space [20].

Though AAI has been used in numerous health and learning contexts, to date, except for an AAA pilot study, the authors are unaware of the use of AAI in healthcare simulation. The pilot study was conducted with 13 Medical Laboratory Assistants (MLAs) and 18 Advanced Care Paramedic (ACP) students to investigate the effectiveness and feasibility of running an AAA after a highly challenging and stress-inducing simulation. Pilot study results indicated that AAA appears to be beneficial for reducing self-reported anxiety, stress and confusion post-simulation in both MLA and ACP students. Students reported that the AAA had a positive emotional impact, expressed enthusiasm about the opportunity to engage with a canine post-simulation, and were unanimous in their desire to have AAA be made available in the future. The positive effects and student enthusiasm indicate that AAA has a high potential for use in simulation [20].

Though prior research has demonstrated that AAIs can be effective, a major methodological shortcoming in the AAI literature, including the reported pilot study, is a lack of comparison against an intervention control group. Typically, AAI has been compared with a no-intervention or wait-list control group. In the AAI literature, there is a need to compare AAIs against interventional controls to determine if there is something specific to the experience or process of an AAI that is effective [21,22]. Previously, relaxation techniques that include a breathing component implemented post-stimulation have been shown to positively impact learning [2]. The purpose of this study was to systematically investigate the effect of an AAA on post-simulation negative affective arousal. A research question was developed:

Is there a difference in the measures of affective arousal related to (di)stress between an AAA and a diaphragmatic breathing control post-simulation?

Methods

Sampling

This study used a convenience sample. Programme facilitators from all programmes at a single post-secondary institution conducting simulation during the study period were contacted to determine if they would permit the recruitment of students for research activities to take place during the programmes' regularly scheduled simulation times. Time for the AAA was requested during simulations that facilitators had previously observed to induce a high degree of stress and negative emotional reactions in participants. All programmes expressed interest though the programmes included were those where the facilitator expressed interest in allowing the study to take place, a previously observed high stress/negative emotional reaction simulation was planned, and the canine and handler were available. There were programmes interested in participation that were not able to meet these criteria. Ultimately, participants were recruited from Primary Care Paramedic (PCP), Respiratory Therapy (RT), and Animal Health (AH), composed of Veterinary Medical Assisting and Animal Health Technology. All programmes had prior simulation experience.

The PCP scenario was a workplace trauma involving electrocution and a fall, the RT scenario involved the removal of life support from a paediatric patient, and the AH scenario involved a pet dog that had been seriously injured in a dog attack. Two weeks before the target simulation date, participants were informed of the study by the researchers during class time. There were no inclusion/exclusion criteria for the study besides programme enrolment; however, participants with a fear of canines, allergies or any other mitigating factors were informed they did not need to participate in the study. On the day of the simulation, before the beginning of the simulations, participants were reminded by the researchers that the study was being conducted that day. The researchers had no prior relationship with the students and did not have any influence over the participant's grades or academic standing. Informed consent was obtained from all participants. Ethics approval was provided by the Northern Alberta Institute of Technology (NAIT) Research Ethics Board: Research Ethics Application #2022-07.

Procedures

Participants completed the simulation pre-briefing and the simulation as normal. Immediately upon completion of the simulation and before the debriefing, as participants left the simulation theatre, the participants were greeted by a researcher and asked to scan a QR code using their personal devices, which brought participants to the study materials. The study was hosted on the survey software Qualtrics [23]. After completing a set of measures of affective arousal, participants were randomized to the Canine or Control condition. Randomization was conducted through Qualtrics. Based on the condition assignment, participants entered a room and interacted with the canine or entered a separate room to complete the breathing exercise. Based on the number of participants in the simulation and randomization, 1–2 participants entered the room at a time for each condition, for example, if 3 participants were in the simulation, 2 may be randomized to the canine and 1 to the breathing condition. Participants in each condition were fully sequestered from the other condition. The participants had no interaction with the therapy canine or handler before entering the room with the canine. Based on the study design, blinding was not possible. On request from the programmes to minimize the time of the AAA, participants spent 2.5 minutes in each condition. After 2.5 minutes, participants were informed that the intervention was over, exited the room and completed the affective arousal measures again. After completion, participants were thanked and informed that participation in the study was complete.

Conditions

Canine condition

The therapy canine was a 9-year-old, 45-pound male-neutered Australian Labradoodle. The canine and handler are an experienced team evaluated through the Therapeutic Animal Assisted Interactions Leadership Society (TAAILS) [24] by two separate animal behaviour specialists and deemed fit for human–animal interventions. The handler is a Registered Nurse, Registered Professional Counsellor, certified human–animal intervention specialist, and is employed with Student Counselling. As a part of AAA best practice, the handler must have training in providing counselling and remain with the canine throughout the therapy session. The handler's role is to ensure a safe interaction can be experienced by both the humans and the animal during interactions, and this includes observing for signals from the dog's body language and posturing that can indicate interest, content, stress or fatigue. The client's interaction is focused on the animal; however, the handler must be present in the case that further intervention or communication is required or desired by the client. If further intervention was required by the client, the counsellor's intervention would occur separately and after the canine interaction was completed.

Participants entered the room and could choose how they would like to interact with the canine and handler. Mats and toys were provided so that students could comfortably interact with the canine, to the level they were comfortable with. During an AAA, the degree of interaction with the animal should be determined by the client and even the presence of an animal, with no physical interaction with the animal, can have a therapeutic effect [9–12].

Breathing condition

Diaphragmatic breathing was selected as the control condition based on the ease of administration and effectiveness of breath work for reducing stress and prior positive evidence for post-simulation relaxation techniques that include a breathing component [2,25]. Participants completed the breathing exercise in a quiet room with low lighting. Before entering the room, participants were asked to respect the other participants and complete the breathing according to the instructions provided. Instructions and timing for the breathing group were built into the Qualtrics survey. Breathing instructions were only presented to participants assigned to the breathing condition. Participants followed the instructions on their personal devices. Instructions for diaphragmatic breathing were from Cleveland Clinic [26] and University of Michigan Health [27] protocols. Instructions provided to participants were to (1) sit in a comfortable position, close your eyes; (2) place one hand on your chest and one hand on your abdomen. The bottom hand should do the moving. The top hand should remain still or only move as the bottom hand moves; (3) inhale through your nose for about 4 seconds, feeling your abdomen expand (You may feel slight tension the first few times you inhale); (4) hold your breath for 2 seconds; (5) exhale very slowly and steadily through your mouth for about 6 seconds. The mouth should be relaxed; 6) repeat until the time is complete.

Measures and analysis

Arousal can be investigated through immediate affective states where different affective states, such as anxiety, stress, confusion, sadness and anger, in excess, can contribute to the inhibition of performance or learning and can be considered negative states of affective arousal [2,16,19]. In the present study, affective arousal responses were obtained using a Visual Analogue Scale (VAS) hosted on Qualtrics. The VAS consists of a 100-point line anchored by *the absence of emotion* and *the most experienced*, for example, 0 = no stress, 100 = greatest amount of stress experienced. Using a slider scale on the Qualtrics survey software, participants were asked to indicate what point on the scale line between 0 and 100 matched their current state, a dot was moved along the line with a corresponding number indicating the point on the scale [28]. VASs have good psychometric properties and have demonstrated validity and reliability for measuring affective traits such as stress and anxiety and have been shown to be effective in both animal-based and simulation-based research [2,19,28,29]. Measures were taken for five affective responses related to negative arousal: anxiety, stress, confusion, sadness and anger. The use of a VAS and the five selected measures have been used in prior research to examine the effects of stress reduction with academic and healthcare-based samples, including with canines [2,19, 28,30] and specifically in research examining change in negative affective states post-simulation and prior to debriefing [2]. Prior research has also shown corresponding decreases in physiologic response measures for each of the measures used[2,19].

The measures used represent different aspects of affect, associated with stress, that could each contribute to excessive negative affective arousal, producing distress and ultimately inhibiting learning [2,19]. For example, in a simulated scenario for paediatric withdrawal of care, a student may rate sadness very high and other measures low; however, the high negative affective arousal of sadness elicits an excessive stress response producing distress, inhibiting learning in the scenario or debriefing. For another learner, the same scenario may elicit high anxiety, contributing to distress and inhibiting learning. The five measures are intended to cover a range of potential affective responses rather than collectively contribute to a single-factor variable representing overall negative affective arousal. Aggregate scoring of the five measures would be inappropriate due to the lack of validity evidence for aggregating the measures for use as a global representation of arousal. Each VAS subscale was used as an outcome variable, with the primary measure being the delta between pre–post intervention VAS subscale scores. The planned analysis involved separate 2 × 3 ANOVAs conducted for each VAS subscale to examine the effects of Program × Condition and potential interactions; Program = RT × PCP × AH, Condition = Breathing × Canine. A priori power calculations indicated that for the study design with $\alpha = 0.05$ and a medium effect size, to have a Power $(1 - \beta) = 0.8$, a sample size of 64 would be required.

Results

Descriptives and pre-analysis checks

A total of 45 students participated in the study, PCP = 17, AH = 21, RT = 7, with 23 assigned to the Breathing condition and 22 assigned to the Canine condition. For the PCP and AH programmes, the participants recruited represented the entire cohort of students present on the day the study was scheduled. Due to programme scheduling changes and the availability of the canine and handler, only 17.5% (7/40) of the anticipated RT students were able to participate. No students declined participation.

In the canine condition, participants interacted with the canine by gently petting the canine, speaking to the canine or playing with the canine by using the toys, for example, tossing the toy for the dog to 'fetch' or playing 'tug of war'. With the handler, participants engaged in phatic communication about the name, age, sex and breed of the dog. In the breathing condition, while participants could not be obligated to engage in the breathing exercise, it appeared to the researchers that all participants did complete the breathing exercise as instructed or at least sat quietly. Participants did not speak with or appear to disturb each other if there was more than one participant in the room.

Participants were evenly distributed across conditions (see Table 1, Supplemental Digital Content 1, which reports all extra statistical analysis and descriptive information for the study). As the RT sample had cell sizes of <5 for each condition, compromising the statistical reliability of a 2 × 3 design, RTs were removed from the analysis, and a 2 × 2 ANOVA was conducted, Program = PCP × AH, Condition = Breathing × Canine. A separate analysis, t-test, including RT participants, was conducted to examine the effect of condition across programme/simulation. As it was not possible to include the RT sample in the ANOVA, this approach allows for an investigation of the effect across conditions notwithstanding programme/simulation effects and can lead to more robust conclusions.

Post-hoc power calculation [31] for a 2 × 2 ANOVA (Canine vs. Breathing and PCP vs. AH, α = 0.05, medium effect size) with interaction effects was $1 - \beta = 0.3$. The post-hoc power calculation for a t-test (Canine vs. Breathing, participants pooled across programmes, α = 0.05, medium effect size) was $1 - \beta = 0.5$. Though the study was underpowered, analyses proceeded as detecting any effects under the increased risk of Type II error would provide evidence for a true effect.

On the post-simulation pre-intervention measures, participants reported moderate Anxiety, Stress and Confusion, and low Anger and Sadness (Table 1). No significant differences existed between PCP and AH participants on any pre-intervention measures (Table S2). No significant differences existed between the Breathing and Canine condition on the VAS before the intervention except for on the Anger scale, p = .02, Cohen's d (95% CI) = 0.81 (0.12 – 1.5), Mean Difference = 8.0. The mean Anger scores for both conditions were low, Canine = 2.56 (SD = 4.95, Median = 0.0), Breathing = 10.6 (SD = 12.8, Median = 8.0). Based on the low mean scores and large variance (SD) around a Median of 0 (Tables 1 and 2), it is likely that the simulations were not eliciting Anger and student reporting on Anger was likely random responding. To avoid drawing spurious conclusions around the measure of Anger, Anger was removed from all further analyses. Paired samples t-tests indicated that participants' emotional affect decreased significantly from pre- to post-intervention across both conditions on all measures (Tables 1 and S3).

Change in emotional affect by programme and condition

Anxiety

For Δ Anxiety, there were no violations of assumptions for ANOVA; Shapiro–Wilk p = .84, Levene's test p = .57. There was a significant overall model effect for Δ Anxiety $F(3, 34) = 4.62$, p = .008. A significant difference existed for Program $F(1, 34) = 8.03$, p = .008, $\eta^2 = 0.17$, with a greater decrease in Anxiety for AH students 33.8 (SD = 18.2, Median = 32.0) than PCP students 19.8 (SD = 13.4, Median = 17.0), mean difference = 14). A significant difference also existed for Condition $F(1, 34) = 4.18$, p = .049, $\eta^2 = 0.09$, with a greater decrease in the Canine Condition 33.3 (SD = 19.5, Median = 30.0) than in the Breathing condition 22.3 (SD = 14.1, Median = 20.0), mean difference = 11. No interaction effect was identified $F(1, 34) = 1.34$, p = .26, $\eta^2 = 0.03$ (Tables 2 and 3, Table S4).

Stress

For Δ Stress, there were no violations of assumptions for ANOVA; Shapiro–Wilk p = .25, Levene's test p = .05. There was no significant overall model effect for Δ Stress $F(3, 34)$ =.89, p = .45; no significant difference for Program $F(1, 34) = 1.93$, p = .17, $\eta^2 = 0.05$, Condition $F(1, 34)$ =.36, p = .57, $\eta^2 = 0.009$, and no interaction effects $F(1, 34)$ =.41, p = .53, $\eta^2 = 0.01$ (Tables 2 and 3, Table S4).

Confusion

For Δ Confusion, there was no violation of normality, Shapiro–Wilk p = .12, there was a significant violation of Homogeneity of Variance, Levene's test p = .02, the Games–Howell Correction was applied. There was no significant overall model effect for Δ Confusion $F(3, 4)$ = 2.4, p = .09, though a significant difference emerged for

Table 1: Descriptive statistics for overall change in emotional affect (RT excluded)

	Anxiety			Stress			Confusion			Anger			Sadness		
	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ	Pre	Post	Δ
Mean	46.3	20.5	25.8	45.2	19	26.2	30.2	8.78	21.4	5.73	3.07	2.67	15.4	3.4	12
Median	50	12	25	49	10	23	23	0	10	0	0	0	5	0	5
SD	26.7	21.4	17.1	27.4	22.3	19.5	28.5	18.9	24	10	12.6	7.38	22.4	6.66	18.4
IQR	36	30	30	41	30	30	42	8	29	10	0	6	22	4	18
Range	100	85	70	100	85	79	100	71	80	50	81	49	100	25	84
Minimum	0	0	0	0	0	-9	0	0	0	0	0	-31	0	0	-5
Maximum	100	85	70	100	85	70	100	71	80	50	81	18	100	25	79

Table 2: Descriptive statistics for change in VAS scales by Program (RT excluded)

Programme	N		Mean		Median		SD		Minimum		Maximum	
	PCP	AH	PCP	AH	PCP	AH	PCP	AH	PCP	AH	PCP	AH
Δ Anxiety	17	21	19.8	33.8	17	32	13.4	18.2	0	5	42	70
Δ Stress	17	21	23.8	32.5	23	30	19.8	18.8	-9	4	54	70
Δ Confusion	17	21	14.4	31.5	10	30	16.5	27.9	0	0	66	80
Δ Anger	17	21	2.18	3.95	0	0	10.2	5.64	-31	0	18	16
Δ Sadness	17	21	11.9	10.1	0	0	21.8	16.6	-5	0	79	60

Program $F(1, 34) = 5.3$, $p = .03$, $\eta^2 = 0.13$, with a greater decrease in Confusion for AH students 31.5 (SD = 27.9, Median = 30.0) than PCP students 14.4 (SD = 16.5, Median = 10.0), mean difference = 17.1. There was no significant effect for Condition $F(1, 34) = 0.64$, $p = .43$, $\eta^2 = 0.02$, and no interaction effects $F(1, 34) = 1.3$, $p = .27$, $\eta^2 = 0.03$ (Tables 2 and 3, Table S4).

Sadness

For Δ Sadness, there was a violation of normality, Shapiro–Wilk $p < .001$, and no violation of Homogeneity of Variance Levene's test $p = .14$. There was no significant overall model effect for Δ Sadness $F(3, 34) = 0.64$, $p = .59$; Program $F(1, 34) = 0.6$, $p = .8$, $\eta^2 = 0.002$; Condition $F(1, 34) = 1.4$, $p = .25$, $\eta^2 = 0.04$, and no interaction effects $F(1, 34) = 0.61$, $p = .43$, $\eta^2 = 0.02$ (Tables 2 and 3, Table S4).

Change in emotional affect across programmes

When data were pooled across programmes to include RT participants independent samples t-tests indicated the only significant change in emotional affect was for Δ Anxiety, $t(19) = 2.21$, $p = .039$, with participants reporting a greater decrease in Anxiety in the Canine condition 31.1 (SD = 18.6, Median = 30.0) than in the Breathing condition 20.7 (SD = 14.1, Median = 20.0), mean difference = 10.4, Cohen's d (95% CI) = 0.64 (0.02–1.24) (Table 4, Tables S5 and S6). These results align with those of the Program × Condition ANOVA, including the RT students did not substantially alter the findings.

Observations

Throughout the course of the study, there were unanticipated reactions from participants. Participants frequently indicated a hope to be randomized to the Canine condition instead of the Breathing condition and even expressed disappointment at being assigned to the Breathing condition. Participants verbally expressed satisfaction and pleasure from interacting with the canine and this positive sentiment was echoed by facilitators, who indicated that the canine positively affected them and helped them feel less 'stressed' during a busy simulation day.

Table 3: Descriptive statistics for change in emotional affect by Condition (RT excluded)

Programme	N		Mean		Median		SD		Minimum		Maximum	
	BREATH	DOG	BREATH	DOG	BREATH	DOG	BREATH	DOG	BREATH	DOG	BREATH	DOG
Δ Anxiety	20	18	22.3	33.3	20	30	14.1	19.5	0	0	50	70
Δ Stress	20	18	26.6	30.8	24	35.5	14.8	23.9	0	−9	50	70
Δ Confusion	20	18	20.4	27.6	16	10	18.4	30.5	0	0	70	80
Δ Anger	20	18	3.8	2.44	4	0	10	4.9	−31	−1	18	13
Δ Sadness	20	18	14.2	7.28	0	2	23.3	11.7	−5	−4	79	40

Table 4: Independent samples t-tests comparing subscales of VAS for conditions pooled across programmes[a]

					95% Confidence interval			95% Confidence interval		
	Test statistic	df	p	Mean difference	Lower	SE difference	Upper	Lower	Effect size[c]	Upper
Δ Anxiety	2.13	43	.039	10.44	−20.33	4.9	−0.56	.02	0.64	1.24
Δ Stress	1.02	43	.313	5.92	−17.61	5.80	5.77	−0.29	0.31	0.89
Δ Confusion[b,d]	0.92	43	.363	6.6	−21.08	7.18	7.88	−0.32	0.27	0.86
Δ Anger[d]	0.59	43	.559	1.3	−3.17	2.22	5.78	−0.41	0.18	0.76
Δ Sadness[d]	0.48	43	.633	2.67	−8.51	5.54	13.84	−0.44	0.14	0.73

[a]Analysis including RT students.
[b]Levene's test is significant ($p < .05$), suggesting a violation of the assumption of equal variances.
[c]Cohen's d.
[d]Violation of normality based on Shapiro Wilks and QQ plots.

There were no negative reactions towards the canine and students were excited to be included in the study.

Discussion

Both the Canine and the Breathing conditions were effective in reducing affective arousal as measured by self-reported anxiety and confusion from pre- to post-intervention. Participants from the AH programme experienced a greater reduction in Anxiety than participants in the PCP programme, and participants in the Canine condition experienced a greater reduction in Anxiety than those in the Breathing condition. When RT students were included, the effect of the Canine condition on Anxiety remained nearly identical; a Program effect, though no Condition effect, was also observed for Confusion. Based on the trend in means for Stress and Confusion, an effect for the AAA may have been detected with a larger sample size.

The Program effect for Anxiety and Confusion and the trend in means indicate that PCP students may experience stress in simulation differently than AH students. The possible effect may be due to individual differences, different personal experiences and education before simulation training, and prior simulation exposure. The low post-simulation scores on Anger and Sadness indicate that the simulation did not evoke these emotions, paralleling the results of the initial pilot study [20]. The lack of any interaction effects suggests that the AAA had a uniform effect on participants, that is, emotional affect decreased at roughly the same rate across the programmes. While students in different programmes may be affected by challenging simulations to greater or lesser extents, an AAA to reduce negative emotional affect has roughly the same impact.

The decrease in Anxiety post-simulation and the participant's positive regard and excitement for the Canine indicate that an AAA post-simulation is a viable method for reducing negative emotional affect. Diaphragmatic Breathing also appears to be effective, is less resource intensive, can be implemented almost anywhere, and can be easily taught or guided. AAA and Diaphragmatic Breathing could be used when considering an intervention to reduce (di)stress post-simulation. With consideration of the potentially greater benefit of the AAA, participants' preference for the canine, as well as the extra effort to use an AAA versus breathing, the use of an AAA may be most appropriate when a highly emotionally challenging or upsetting simulation is being conducted or if the simulation is intensive and long-lasting. Many schools and healthcare facilities have AAI programmes making using an AAA safe and highly feasible [11,32,33], though a lack of access to animals and handlers trained in AAA is a limitation to the broader implementation of AAA.

Limitations and Future Directions

There were two primary limitations to the study. (1) Sample size. Due to scheduling challenges, fewer programmes and students were recruited to the study than initially planned. The smaller sample led to the study being underpowered and likely led to Type II errors. Based on observed trends, a study with greater power would likely result in significant effects for Stress and Confusion. Including more programmes would have improved generalizability and allowed for more robust claims about the effect of an AAA across student groups and simulations.

(2) Expectancy effects. Upon being informed of the study and reminded of the study on the simulation day, students were excited about the possibility of interacting with the canine. Some students expressed disappointment after completing the initial VAS and then being randomized to the breathing condition. The expectation and subsequent disappointment of not interacting with the canine may have led to less reduction in emotional affect in the breathing condition. Before the study, students were informed that regardless of condition assignment after the study's conclusion, they would have the opportunity to interact with the canine, potentially mitigating the negative impacts of expectancy effects.

Educational outcomes were not measured; however, measuring educational outcomes was beyond the scope and purpose of the present study, which was to develop an initial understanding of the impact of an AAA on negative affective arousal post-simulation. Relatedly, physiological stress responses were not measured; however, the purpose of this study was to examine the perceived psychological emotional response of participants rather than physiological responses.

Future research should continue investigating AAA in simulation with other healthcare programmes and for longer durations. Having an AAI-specialized animal consistently present in a simulation centre, such as a Canine or Feline, may improve mood and work and learning conditions for simulation staff, educators and students. Further research should examine the effect of reduction in negative emotional affect post-simulation through AAA on learning outcomes and instructor/facilitator performance during debriefing. Positive emotional arousal, such as feelings of happiness, relief and contentment, could also be measured. The use of participant interviews would also be valuable to achieve deeper knowledge about how learners experience the AAA. Phenomenological methods would help to understand the essence of the AAA experience and why an AAA produces beneficial outcomes, is highly anticipated, and is preferential in comparison to diaphragmatic breathing. Longer interaction periods for the AAA should also be investigated.

Conclusions

In this study, across three programmes and simulations, an AAA was demonstrated to reduce negative emotional affect post-simulation and did so at an equivalent or better rate than Diaphragmatic Breathing. Diaphragmatic Breathing is less resource intensive and more easily implemented than an AAA; however, participants expressed excitement and preference for the canine. In healthcare simulation, the use of AAA may be most efficiently utilized when implemented with simulations that are known to be highly emotionally intensive. The use of AAA in simulation is technically feasible and safe. Based on the present study and the larger body of AAI research, AAA can be implemented post-simulation to mitigate negative emotional affect, reduce distress and potentially support learning.

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Competing interests

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