

**Canine-Assisted Intervention Reduces Anxiety and Stress in Higher Education Students: A
Randomised Controlled Trial**

Karen Manville
Psychology Department
Middlesex University
The Burroughs
Hendon
NW4 4BT
KM1332@live.mdx.ac.uk

Mark Coulson
School of Psychology
University of East Anglia
Norwich Research Park
Norwich
Norfolk
NR4 7TJ
M.Coulson@uea.ac.uk

Gemma Reynolds
Psychology Department
Middlesex University
The Burroughs
Hendon
NW4 4BT
G.Reynolds@mdx.ac.uk

Abstract

The purpose of this study was to explore benefits of interacting with a canine on anxiety, stress, depression and well-being in Higher Education students. Sixty participants took part in a randomized controlled trial. Assigned to either the canine-assisted intervention (CAI) or control group, the CAI group interacted with a canine whereas the control group watched an unrelated slideshow. Anxiety, depression, stress and well-being measures were completed pre- and post-intervention and demonstrated there was a significant decrease in anxiety and stress in the CAI group. Due to group differences pre-intervention, findings for depression measures were uninterpretable and there was no significant effect found for general well-being. Overall this study uses a CAI and control group and explores the use of a singular, brief CAI session in HE students demonstrating CAI to be an effective means of supporting mental health by decreasing levels of anxiety and stress in the treatment group.

Keywords

Animal-Assisted-Activities, Canine-Assisted-Interaction, HE Students, Mental Health

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Mental health issues in Higher Education (HE) students are becoming increasingly common (McKenzie, Murray, Aja, & Richelieu, 2015) with one fifth of students struggling with some form of mental health disorder (Auerbach et al., 2016). Brown (2016) suggests students leaving home are vulnerable to mental health issues alongside the stress of tuition debt, navigating new learning environments, and pressure to secure a high class degree. Currently, support available to HE students follows established and traditional routes ranging from the National Health Service (NHS) provision, or onsite mental health services (Thorley, 2017), usually taking the form of counselling (Goodman, 2017).

An alternative mental health intervention gaining popularity is the use of canine interaction (e.g., Adamle, Riley, & Carlson, 2009; Binfet & Passmore, 2016; Le Roux & Kemp, 2008; Nimer & Lundal, 2015; Sobo, Eng, & Kassity-Krich, 2006). Canine interaction interventions have been used in a range of populations resulting in positive effects on a range of emotions and behaviors including anxiety (Buttelmann & Römoke, 2014), homesickness (Binfet & Passmore, 2016), stress (Shearer, Hunt, Chowdhury, & Nicol, 2016), emotional response (Kerns, Stuart-Parrigon, Coifman, van Dulmen, & Kohen, 2016) and pain perception (Sobo et al., 2006).

Referred to in this manuscript as Canine Assisted Intervention (CAI), this intervention is based on Animal-Assisted Interventions (AAI) in that it involves a human interacting with a canine as a means of improving well-being, however there are some important distinctions to be made. In particular, AAI arguably has more structure and planning than CAI (e.g., see Buttelmann & Römoke, 2014). It also generally includes greater longevity, for example, Shearer and colleagues (2016) who ran their study for four weeks. Furthermore, AAI is often designed and led by health professionals (e.g., Elmaci & Cevizci, 2015). However, CAI has been shown to be effective in educational settings such as primary schools (e.g., Pillow-Price, Yonts, & Stinson, 2014).

Despite published studies exploring CAI in HE students (e.g., Barker, Barker, McCain, & Schubert, 2017; Binfet, Passmore, Cebry, Struik, & McKay, 2018; Pendry & Vandagriff, 2019) there is less research with individual HE student participants as the sample population with both an experimental and control group. Recently in a study focusing on loneliness, Stewart, Dispenza, Parker, Chang and Cunnien (2014) found levels of self-recorded anxiety were reduced following one session with an animal assisted outreach program. Crossman, Kazdin, and Knudson (2015) also found that HE participants who interacted with a canine felt a greater reduction in personal feelings of distress and an improvement in anxiety levels compared to participants who merely viewed images of a canine. Other research has demonstrated that HE students who interacted with a canine reported increased feelings of love and support (Dell et al., 2015), a greater sense of stress relief and comfort (Daltry & Mehr, 2015), and reduced stress and anxiety during an induced traumatic scenario (Lass-Hennemann et al., 2018).

However, not all studies exploring CAI with HE students report exclusively positive results. Barker et al. (2003), measuring the effects of canine interaction after electrotherapy treatment found that while fear was reduced, there was no significant reduction in anxiety or depression. Buttelman and Rompke (2014) instructed participants to engage with an intervention (either interacting with a canine, fish or plant) for five minutes after an anxiety inducing task. Unexpectedly, the canine group did not record the greatest reduction in anxiety. However, they did find a decrease in anxiety below the induced anxiety levels after canine interaction. Participants who interacted with the canine also showed more signs of laughter during their session compared to the fish and plant interactions, signaling a greater level of enjoyment and happiness.

While some research exists exploring the benefits of CAI in HE students, this study is unique in that participants took part individually rather than in small groups, it follows strict guidelines including no interaction (particularly any visual opportunities) with the canine other than during the intervention, no social interaction from other persons on site, and all data collection took place in the same quiet room without distraction. In addition, a ten minute interaction with the canine was selected based on previous research that recorded 10

minutes of contact with a therapy dog could buffer stress responses in HE students (Fiocco & Hunse, 2017) and that interaction with a companion animal reduced state and trait anxiety levels (Wilson, 1991).

The study aimed to investigate whether CAI improves anxiety, stress and depression levels as well as general well-being in HE students. Participants were randomly assigned to either receive CAI or an unrelated intervention. It was hypothesized that the CAI group would experience a greater reduction in anxiety, stress and depression levels, as well as an increase in overall well-being, compared to the control group.

Method

Participants

A priori power analysis (G*Power; Faul, Erdfelder, Land, & Buchner, 2007) was carried out indicating a sample size of sixty participants was sufficient to detect a medium effect size. Participants were all HE students (47 females, 13 males) recruited from Middlesex University through posters placed around the university campus and word of mouth. Students were recruited via convenience sampling, and a computer-generated random sequence was used to randomly assign participants to one of two groups, CAI or a control group. Prior to signing the consent form, participants were asked questions to determine their suitability. They were asked whether they had a fear of canines, allergies towards animals and whether they had ever purposely harmed an animal. If participants responded in favor of any of these criteria, they would have been excluded. However, no participants reported fears, allergies or having ever intentionally harmed an animal. Participants ages ranged from 19.1 years to 52 years with a mean age of 25.3 years ($SD = 6.99$, female $M = 25.8$ years, $SD = 7.35$, male $M = 23.4$ years, $SD = 5.35$). Of the 60 participants 66.70% ($n = 40$) were undergraduate students, and 33.30% ($n = 20$) were postgraduate students, enrolled in a range of courses. Ethical approval was obtained by the Psychology Research Ethics Committee and all participants provided signed written consent to take part in the study. Based on this approval, the dog handler (the first author) was trained by K9 Consulting to be aware of the canine needs at all times. Additionally, both the canine and handler received reinforcement training rewarding good behaviour and correcting bad behavior, working towards the canine becoming a therapy dog.

Materials

The study was carried out using Qualtrics on a MacBook Air 13”, OS X El Capitan, 10.11.6. For the control group, a Microsoft PowerPoint presentation was used to display 20 unrelated neutral images taken from the British Vocabulary Scale (Dunn & Dunn, 2009), such as a teapot and a guitar. All images were presented for 30 seconds in color and in random order. A small Dachshund, Jack Russell cross called Elvis (Figure 1), who grew up with small children was used for the CAI intervention. Elvis belongs to the researcher and was with her at all times.



Figure 1. Elvis the dog who participated during the interaction in the CAI group

At all times, Elvis was keen to interact with all participants therefore the handler was not required to intervene in any interactions. Elvis was monitored for signs of fear or distress to ensure both animal welfare and participant safety (see Case, 2015). At no time did Elvis display any of these signs and no more than 3 sessions were scheduled per day. Of these 3 sessions, Elvis only interacted with each participant for 10 minutes. On either side of the 10 minutes intervention participants either completed pre or post-interventions measures

allowing Elvis a 20-25 minute break. In addition Elvis was brought to the lab 15-20 minutes prior to his first intervention to acclimatize him to the setting.

Questionnaire measures

We employed a variety of measures of anxiety, depression, stress, and well-being (described below). We also used the visual analogue scale (VAS) to measure the first three states. For example, the VAS-Anxiety measured current subjective anxiety with *Extremely anxious* at one end of a 100mm scale to *Not at all anxious* at the other giving a score range of 0-10. Participants indicated on the scale how anxious they felt at that current moment. The same scale was used for depression and stress.

State Trait-Anxiety Inventory (STAI, Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983): The STAI comprises two questionnaires measuring trait anxiety and state anxiety, only the state anxiety test was used to identify participants levels of anxiety at that particular moment in time (state anxiety) rather than on day to day anxiety levels (trait anxiety). The measure comprises 20 questions and responses are rated on a four-point scale ranging from *not at all* to *very much so*, and gives a score range of 20-80. Internal consistency was high pre-intervention, Cronbach's alpha (α) = .88, and post-intervention, α = .92.

The Depression, Anxiety, Stress Scale (DASS 21; Nieuwenhuijsen, de Boer, Verbeek, Blonk, & van Dijk, 2003): The DASS was used to measure anxiety, stress and depression. The anxiety measure includes 21 questions (7 questions for each scale) and responses are rated on a four-point scale ranging from *did not apply to me at all* to *applies to me very much or most of the time*, giving an overall score range of 0-120 and for individual subscales, 0-42. Anxiety: Pre-intervention, Cronbach's α = .75; post-intervention, α = .86. Stress: Pre-intervention, Cronbach's alpha (α) = .85; post-intervention, α = .90. Depression: Pre-intervention, α = .88; post-intervention α = .90.

Beck Depression Inventory (BDI, Beck, Steer, & Brown, 1996): The BDI was used to measure depression symptoms. The measure comprises 21 questions with responses rated on a four-point Likert-type scale which

gives a score range of 0-63. Internal consistency was high pre-intervention, Cronbach's $\alpha = .92$, and post-intervention, $\alpha = .93$.

The Ryff Scale (RYFF, Ryff, 1989): Recommended by Ryff for use specifically in HE, the RYFF scale measures elements of well-being related to autonomy, environmental mastery, purpose in life, self-acceptance, personal growth and positive relations with others (Ryff, 1989). The nine-item version was used consisting of 54 questions sub divided into nine questions for each element. Responses are rated on a six-point scale ranging from *strongly agree* to *strongly disagree*, and gives an overall score range of 59-310 with the subscales ranging from 9-54, except for autonomy which ranges from 14-49. Cronbach's alpha was high pre-intervention, $\alpha = .94$, and post-intervention, $\alpha = .95$.

The Checklist Individual Strength (CIS, Beurskens et al., 2000): The CIS was used to measure subjective feelings of fatigue, concentration, motivation and physical activity. Consisting of 20 questions, the measure is subdivided depending on the subscale and responses are rated on a seven-point scale ranging from *yes that is true* to *no that is not true* giving an overall score range from 20 -140, with the subscales ranging from 8-56 for fatigue, 5-35 for concentration, 4-28 for motivation, and 3-21 for physical motivation. Pre-intervention, Cronbach's $\alpha = .65$, and post-intervention, $\alpha = .71$.

Procedure

Through pre-arranged appointments, participants were tested individually in a lab on campus at Middlesex University. Participants were randomly allocated to either the CAI group or control group through a computer-generated random sequence. The duration of the study was approximately 50 minutes. Participants first completed a demographics questionnaire including age, gender, course and level, ethnic background and whether they had a canine at home.

Pre-intervention: Measures were presented to both groups in the same order (VAS-Anxiety, VAS-Stress and VAS-Depression, BDI, CSI, STAI, DASS21 and RYFF). All measures were completed without the canine present.

Intervention: The CAI group interacted with the canine for 10 minutes. Toys and treats were not provided for use during the interaction. Participants were in control of the level of interaction with the canine that they felt comfortable with. Petting and talking to the canine were the most common interactions. Before the intervention, participants were told they could interact with the canine by talking to him or petting him. They were also given clear instructions to ensure the canine did not experience any stress including allowing him to come close to the participant before petting him gently, not chasing him, and not making any sudden actions. Participants were informed the experimenter would remain in the room but not be involved in the intervention. The level of interaction with the canine was left to the participant to establish. The experimenter stayed in sight of both canine and participants, and monitored the timing of the session.

The control group received no CAI and were instead given a neutral task of watching a power-point with unrelated (non-animal) neutral images for 10 minutes. Again participants were informed the experimenter would remain in the room and monitor the timing of the session but would not take part in the intervention.

Post-intervention: The questionnaire measures were presented for a second time in the same pre-intervention order. At the end of the session participants were fully debriefed. This included information on the aim of the research, who participants could contact to learn more about companion animal/animal therapy or if they required support regarding their own mental health. The canine was not present post-intervention.

Results

Statistical analysis

Two-way 2 (group: CAI vs control) × 2 (phase: pre vs post) mixed ANOVAs were carried out on all measures to determine statistically significant differences. Significant interactions were followed up with simple effect analyses. Alpha = 0.05 was set as the rejection criterion in all analyses. Effect sizes are reported as partial eta-squared (η^2_p). Whether or not participants had a companion animal at home was initially factored into analyses but was not significant, therefore was excluded from all subsequent analyses.

Pre-Existing Differences

T-tests were conducted on all pre-intervention measures to check for pre-existing differences before the intervention. There was a significant difference between the CAI group and the control (Table 1) at pre-intervention for the VAS-Depression scores, $t(58) = 2.45, p = .017$, BDI scores, $t(58) = 3.29, p = .002$, DASS-Depression scores), $t(58) = 2.83, p = .006$, RYFF-Environmental Mastery scores, $t(58) = -2.43, p = .018$, and the RYFF-Self-Acceptance scores), $t(58) = -2.99, p = .004$. These pre-existing differences must be taken into account when interpreting the results and will be discussed further in the discussion.

Measure	Group	Pre Mean (SD)	Post Mean (SD)
VAS- Anxiety	CAI	5.17 (2.74)	4.20 (2.95)
	Control	5.17 (3.00)	4.10 (2.94)
STAI	CAI	44.63 (10.90)	33.87 (11.22)
	Control	41.83 (8.87)	40.77 (10.05)
DASS- Anxiety	CAI	5.40 (4.17)	3.93 (3.81)
	Control	4.97 (4.32)	5.27 (5.09)
VAS- Depression	CAI	5.07 (3.23)	2.87 (2.78)
	Control	3.20 (2.64)	3.13 (2.52)
BDI	CAI	17.37 (11.25)	12.30 (11.50)
	Control	9.30 (7.37)	8.53 (5.90)
DASS- Depression	CAI	9.83 (5.23)	7.77 (5.76)
	Control	6.23(4.58)	6.50 (5.21)
VAS- Stress	CAI	4.93 (2.30)	3.57 (2.49)
	Control	5.53 (3.12)	5.93 (2.95)
CIS- Fatigue	CAI	37.97 (8.92)	32.50 (10.62)
	Control	36.70 (9.70)	36.53 (8.90)
CIS- Motivation	CAI	16.20 (5.28)	14.43 (5.70)
	Control	14.77 (4.95)	16.47 (5.31)
RYFF- Self-Acceptance	CAI	32.73 (8.25)	37.33 (9.64)
	Control	39.07 (8.17)	39.03 (6.57)

Table 1 reports mean scores (and SD) pre-to-post-intervention for CAI and the control group for VAS-Anxiety, VAS- Stress, VAS- Depression, BDI, STAI, DASS- Anxiety, DASS- Depression, CIS Fatigue and Motivation and RYFF Self-Acceptance measures.

Anxiety

Table 2 shows the ANOVA findings for anxiety measures, pre and post-intervention, in the CAI and the control group and shows a reduction in anxiety measured by the VAS-Anxiety from pre-intervention to post-intervention in both groups. A 2×2 mixed ANOVA (Table 2) was carried out on VAS-Anxiety scores (Table 1) and revealed a significant main effect of phase. Therefore regardless of group, participants were less anxious post-interaction compared to pre-interaction. Remaining findings were nonsignificant (see Table 2),

demonstrating no significant change in anxiety, as measured by the VAS, from pre-to-post-intervention, based on the intervention type.

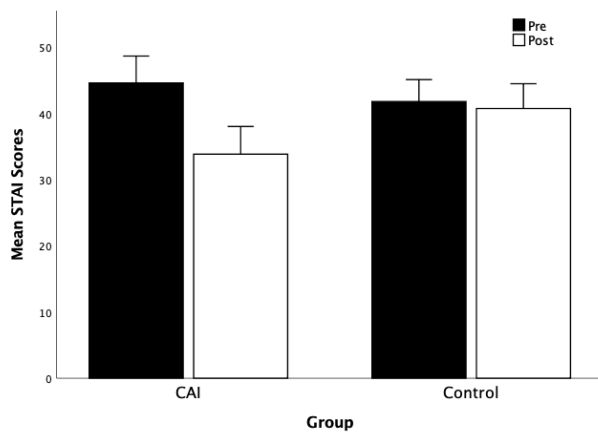
Measure	Main Effects and Interactions	$F(1,58)$	η^2_p	95% CI
VAS- Anxiety	Phase	7.54**	.12	[.003, 0.10]
	Group	.01	< .01	[0, .002]
	Phase \times Group	.02	< .01	[0, .004]
STAI	Phase	28.82**	.33	[.05, 0.21]
	Group	.718	.01	[0, .04]
	Phase \times Group	19.37**	.25	[.03, .17]
DASS- Anxiety	Phase	2.00	.03	[0, .05]
	Group	.18	.003	[0, .03]
	Phase \times Group	4.59**	.07	[0, .08]
VAS- Depression	Phase	9.96**	.15	[.007, .12]
	Group	1.62	.03	[0, .05]
	Phase \times Group	8.83**	.13	[.005, .11]
BDI	Phase	7.23**	.11	[.003, .10]
	Group	7.58**	.12	[.003, .10]
	Phase \times Group	3.93*	.06	[0, .07]
DASS- Depression	Phase	2.81	.05	[0, .06]
	Group	3.89*	< .06	[0, .07]
	Phase \times Group	4.72*	.00	[0, .08]
VAS- Stress	Phase	1.46	.03	[0, .05]
	Group	6.5**	.10	[.002, .09]
	Phase \times Group	4.88**	.08	[0, .08]
CIS- Fatigue	Phase	4.15*	.07	[0, .07]
	Group	.46	.008	[0, .03]
	Phase \times Group	3.67	.06	[0, .07]
CIS- Motivation	Phase	.003	.01	[0, .001]
	Group	.06	.001	[0, .01]
	Phase \times Group	7.94**	.12	[.004, .10]
RYFF- Self Acceptance	Phase	4.58*	.07	[0, .08]
	Group	4.78*	.08	[0, .08]
	Phase \times Group	4.72*	.08	[0, .08]

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 2 reports the results of the 2 \times 2 mixed ANOVAs conducted on the VAS- Anxiety, STAI, DASS- Anxiety, VAS- Depression, BDI, DASS-Depression, VAS- Stress, CIS- Fatigue and Motivation and RYFF- Self Acceptance.

Figure 2a displays the mean state anxiety scores measured by the STAI, indicating a slight reduction in anxiety post-intervention in the control group, but a substantially larger reduction post-intervention anxiety in the CAI group. Findings of the 2×2 mixed ANOVA can be found in Table 2. The significant phase × group interaction demonstrates an effect of intervention from pre-to-post-intervention that differed across the two groups. To identify where the differences lie, simple effect analyses revealed a significant difference from pre-to-post-intervention in the CAI group, $F(1, 58) = 47.72, p < .001$ (95% CIs [.10, .29]), but no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = 0.47, p = .50$ (95% CIs [0, .03]). Therefore, CAI was effective in reducing state anxiety, compared to the control group, as measured by the STAI.

2a



2b

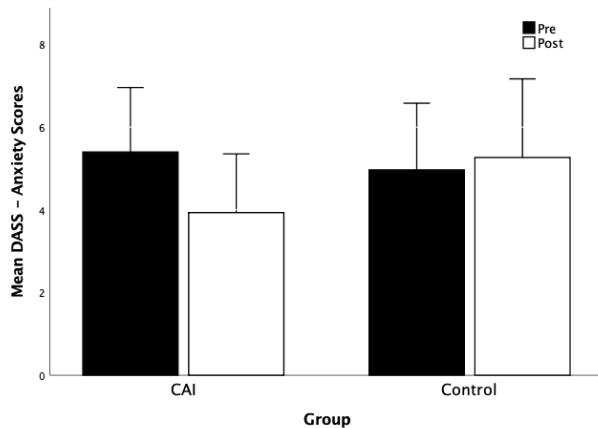


Figure 2.

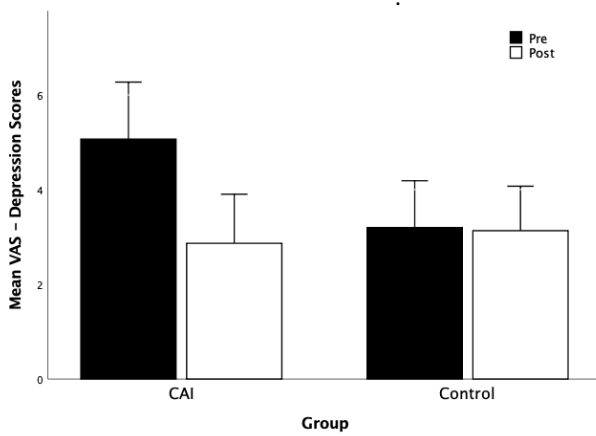
Figure 2 displays mean scores (SE bars) pre- and post-intervention for CAI and control group across anxiety measures. Figure 2a. demonstrates STAI means. Figure 2b. demonstrates DASS-Anxiety means.

DASS-Anxiety scores are shown in *Figure 2b*, indicating a slight increase in anxiety in the control group and a considerable reduction in anxiety in the CAI group. Table 2 reports the findings from the 2×2 mixed ANOVA. The significant interaction was followed up with simple effect analyses indicating a significant difference pre-to-post-intervention in the CAI group, $F(1, 58) = 6.33, p = .02$ (95% CIs [.001, .09]), however no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = .26, p = .61$ (95% CIs [0, .03]). In line with the results from the STAI, findings indicate that CAI was effective, compared to the control group from pre-to-post intervention in reducing anxiety as measured by the DASS.

Depression

Figure 3a displays the VAS- Depression scores and indicates a slight reduction in self-reported depression in the control group but a greater reduction in depression in the VAS- Depression CAI group. It is also clear that there are significant differences pre-intervention (see ‘Pre-Existing Differences’ earlier). That is, at pre-intervention, VAS-Depression scores in the CAI group were already higher than the control group. Subsequently, the CAI group had a larger scope for a reduction in VAS-Depression scores compared to the control group. Indeed, the post-intervention scores for the CAI group are comparable to the post-intervention scores for the control group. Results of the 2×2 mixed ANOVA (Table 2) did reveal a significant phase × group interaction. Simple effect analyses revealed a significant difference from pre-to-post-intervention in the CAI group, $F(1, 58) = 18.77, p < .001$ (95% CIs [.03, .17]), but no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = 0.02, p = .90$ (95% CIs [0, .004]). However, given the significant differences between CAI and the control group at pre-intervention, interpretation of these simple effects must be made with caution. Although it appears that CAI did reduce depression levels, comparing to a control group that had much lower baseline measures at pre-intervention is misleading.

3a



3b

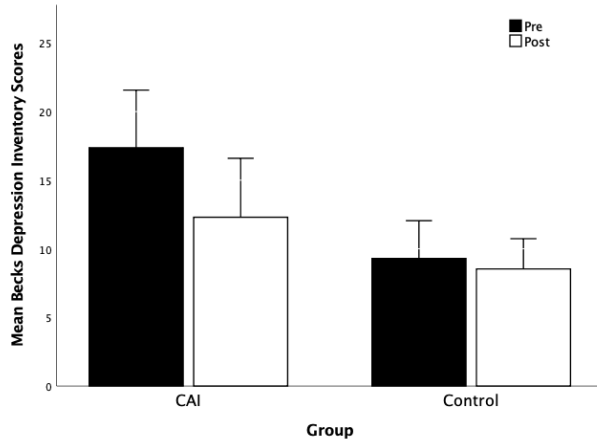


Figure 3.

Figure 3 displays mean scores (SE bars) pre- and post-intervention for CAI and control group across depression measures. Figure 3a. demonstrates VAS-Depression means. Figure 3b. demonstrates Becks Depression Inventory means.

Figure 3b shows the mean BDI scores, pre-and-post-intervention demonstrating a decrease in depression post-intervention in the control group but a much larger reduction in the CAI group. Importantly, similar pre-existing differences exist here as occurred for the VAS-Depression. That is, pre-intervention BDI scores were significantly greater for the CAI group compared to the control group. The 2×2 mixed ANOVA (Table 2) revealed the phase × group interaction was approaching significance. Simple effect analyses revealed a significant difference from pre-to-post-intervention in the CAI group, $F(1, 58) = 10.90, p = .002$ (95% CIs [.009, .12]), but no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = 8.82, p = .62$ (95% CIs [.005, .11]). These results are comparable to those of the VAS-Depression. That is, while it

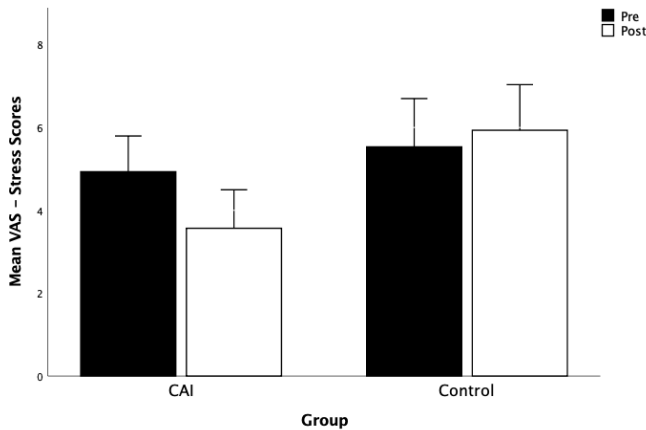
seems to be the case that CAI reduces depression, the pre-existing differences between the CAI group and control group must be taken into account when interpreting these findings.

Reductions in the DASS-Depression scores are similar to those found for the BDI. That is, there was a slight decrease in depression in the control group and a considerable reduction in the CAI group. The 2×2 mixed ANOVA revealed no significant effects indicating CAI had no significant effect in reducing depression, compared to the control group, as measured by the DASS-Depression.

Stress

Figure 4 displays the pre and post-intervention scores for the stress measures. *Figure 4a* shows a slight increase in the control group but a large drop in VAS-Stress scores in the CAI group. The 2×2 mixed ANOVA (Table 2) demonstrated a significant phase × group interaction. Simple effect analyses revealed a significant difference pre-to-post-intervention in the CAI group, $F(1, 58) = 5.84, p = .02$ (95% CIs [.009, .12]), but no significant difference pre-to-post-intervention in the control group, $F(1, 58) = 0.50, p = .48$ (95% CIs [0, .03]), indicating CAI was effective in reducing stress as measured by the VAS-Stress from pre-to-post-intervention in comparison to the control group.

4a



4b

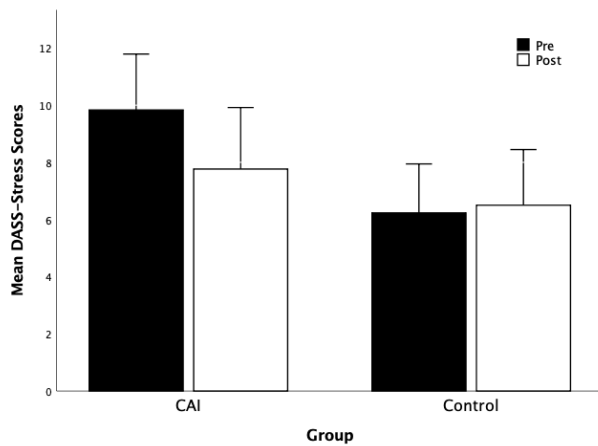


Figure 4.

Figure 4 displays mean scores (SE bars) pre- and post-intervention for CAI and control group across stress measures. Figure 4a. demonstrates VAS-Stress means. Figure 4b. demonstrates DASS-Stress means.

Figure 4b displays the mean pre-to-post-intervention DASS-Stress scores in the CAI and control group. The graph shows a slight increase in the control group and a reduction in the CAI group. Findings from the 2×2 mixed ANOVA (Table 2) reveal a significant group × phase interaction. Simple effect analyses revealed a significant difference from pre-to-post-intervention in the CAI group, $F(1, 58) = 7.42, p = .009$ (95% CIs [.003, .10]), but no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = .12, p = .73$ (95% CIs [0, .04]). In line with the VAS-Stress, these results indicate CAI was effective in reducing stress, compared to the control group, as measured by the DASS- Stress.

Checklist Individual Strength (CIS)

Table 1 displays the mean CIS scores for fatigue, concentration, motivation and physical activity in the CAI and the control group pre and post-intervention. Although fatigue decreased in both groups post-intervention, the CAI group reported a greater decrease. The 2×2 mixed ANOVA of fatigue scores (Table 2) revealed a significant main effect of phase. Remaining findings were nonsignificant. Therefore, there was no significant difference in fatigue levels between the CAI group and the control group, pre and post-intervention.

There was also a slight reduction in both groups post-intervention in concentration scores. The 2×2 mixed ANOVA revealed no significant effects, therefore concentration scores show no differences between the CAI group and the control group pre-to-post-intervention. There was a slight increase in the control group and a slight decrease in the CAI group from pre-to-post-intervention (see Table 1) in motivation levels. Table 2 presents the finding of the 2×2 mixed ANOVA demonstrating a significant phase × group interaction. Simple effects revealed a significant reduction in motivation from pre-to-post-intervention in the CAI group, $F(1, 58) = 4.12, p = .05$ (95% CIs [0, .07]) but no significant change from pre-to-post-intervention in the control group, $F(1, 58) = 3.82, p = .06$ (95% CIs [.006, .11]). Finally, CIS mean physical activity scores show a slight reduction in the control group and a slight increase in the CAI group post-intervention. Findings of the 2×2 mixed ANOVA reveal no significant effects. The findings therefore indicate no difference in physical activity in the CAI group compared to the control group.

Ryff Scales of Psychological Well-being (RYFF)

Autonomy scores, pre-and-post-intervention show an increase in the CAI group and a slight decrease in the control group post-intervention. The 2×2 mixed ANOVA revealed no significant effects. Similar trends are found in scores of environmental mastery, with a slight increase in mean scores between the CAI group and a slight reduction in the control group, however all main effects and interactions were again non-significant, $F_s < 1$. The same was true for personal growth, positive relations with others, and purpose in life. That is, there were trends towards increases in mean scores for the CAI group and reductions in the control group. However, all main effects and interactions were non-significant, $F_s < 1$.

Finally, Table 1 shows the mean scores for self-acceptance revealing an increase in the CAI group and a slight decrease in the control group post-intervention. However, similarly to the depression measures, the self-acceptance scores at pre-intervention were significantly lower in the CAI group compared to the control group. This means there is greater scope for change in the CAI group compared to the control group. Results of the ANOVA (Table 2) demonstrated a significant phase \times group interaction. Simple effect analysis revealed a significant difference from pre-to-post-intervention in the HCI group, $F(1,58) = 9.30, p = .003$ (95% CIs [.006, .11]), but no significant difference from pre-to-post-intervention in the control group, $F(1, 58) = <.01, p = .98$ (95% CIs [0, 0]). Interpretation of this finding must be made with caution as although it implies that CAI was effective in increasing self-acceptance, the pre-existing differences cause this conclusion to be misleading.

Discussion

This study using a randomized controlled trial to investigate the influence of CAI on anxiety, stress, depression, and general well-being in HE students, based on one 10 minute CAI session. Findings are consistent with previous work (e.g., Binfet & Passmore, 2016; Crossman et al., 2015) suggesting that CAI has a positive effect on some aspects of mental health in HE students. To summarize the main findings, CAI was found to (1) reduce anxiety as measured by the STAI and DASS and (2) reduce stress as measured by the VAS and DASS. Crucially, the positive effect of CAI was based on a short interaction time of a single 10 minute intervention session. This stands out from previous studies in which participants interacted for longer time periods (e.g., 60 minutes, Dell et al., 2015), for an eight week program of canine interaction (e.g., Binfet & Passmore, 2016), or over 15 points across the academic year (e.g., Daltry & Mehr, 2015). Demonstrating effectiveness in a brief intervention is fundamental for obvious financial and practical reasons. It is worth noting that other studies have found even briefer interventions to be effective (e.g., 5 minutes, Buttellmann & Rompke, 2014; and 7 minutes minimum, Crossman, et al., 2015) therefore future research should focus on carrying out randomized controlled trials looking at the effectiveness of interventions with shorter durations.

CAI was effective across a breadth of measures for anxiety and stress, but results were not entirely consistent across all measures. For instance, anxiety as measured by a VAS showed no significant difference between the CAI group and control group pre to post-intervention. The lack of effect for the VAS-Anxiety is difficult to interpret, given that significant differences were found for the VAS-Stress. One suggestion would be to remove the VAS-Anxiety from future research if it is not effective in discerning differences. However as this is one of the first studies to utilize a VAS in combination with CAI and HE students mental health, and given the significant findings with the VAS- Stress, future research is required to decipher whether it is an appropriate measure in this context. An alternative explanation for the lack of significant effects for the VAS- Anxiety may be due to the order of measures during data collection. Measures could have been presented to participants looking at one trait before moving onto the next (e.g. VAS- Anxiety and STAI followed by VAS-Depression and BDI and VASS- Stress). This would allow participants to focus on one trait at a time rather than moving back and forth between them. However, the DASS is a single measure incorporating depression, anxiety and stress with questions for each trait combined rather than separated. Despite this, both stress and anxiety subscales were significant yet the depression subscale was not.

The most unexpected finding in the current study was in relation to the depression measures. CAI had no significant impact on depression as measured by the DASS. Conversely, results appeared to reveal a significant reduction in the CAI group from pre to post intervention for depression as measured by the Depression-VAS and BDI. However, a critical issue arises when interpreting these findings as there were significant differences at pre-intervention on all depression measures. This is hugely problematic because it means that the CAI group, who showed significantly greater pre-intervention depression, had a greater scope for reduction in depression by virtue of having higher scores to begin with. These pre-existing differences must be considered when drawing conclusions as they can result in the findings appearing misleading. The only authentic conclusion that can be drawn from the depression findings is that the results are uninterpretable and future research is required to unravel whether CAI has an effect on depression. Crucially, this future research must ensure that pre-intervention scores for an experimental and control group are not significantly different. Participants in the current study were randomly allocated to either the CAI group or control group through a computer-generated

random sequence therefore it seems unlikely that the method of randomization was not sufficient. The reason for these pre-existing differences is therefore unclear. It is possible that it could simply be chance variation, but when looking at the post-intervention scores for the VAS-Depression, it is apparent that scores for the CAI group and control group are very similar. This suggests, potentially, regression toward the mean as an explanation for the apparent effect. That is, while only a minority of participants scored particularly high in depression at pre-intervention, by chance they were in the CAI group, and these particularly highly scoring participants elevated the mean.

Another unexpected finding was that the CAI group showed lower motivation post-intervention compared to pre-intervention. One potential explanation is that participants felt less anxious and stressed (as indicated by other measures) making them feel more relaxed and less motivated to take action (see Smith, Hancock, Blake-Mortimer, & Eckert, 2007). Or it may simply be that the constructs of motivation tested by the measure lacked relevance to participants at the time of testing. Surprisingly few of the facets of well-being were impacted by CAI. It may be that the Ryff and CIS were not sensitive enough to demonstrate differences or were not always relevant to participants, although the RYFF was designed specifically for HE students. Grajfoner, Harte, Potter, and McGuigan (2017) used the Warwick-Edinburgh Mental Well-Being Scales (WEMBES) finding improvements in well-being after a 20 minute canine assisted intervention. Therefore, it is possible that alternative measures of well-being may be more valid in this scenario and thus we would not recommend the use of RYFF or CIS in this type of canine interaction study design. The use of different measures of well-being in future studies would help to discern the possibility that CAI may be an effective intervention for emotions such as anxiety and stress but is less effective as an intervention for general well-being – as opposed to there being problems with the use of the RYFF and CIS.

A strength of this study is the use of randomized controlled trials; this method overcomes many of the limitations of previous research in the area by using an experimental approach, an appropriate control group, and a specific duration. In addition the study took place in a quiet room without interruptions or possible influences unlike studies for which the intervention took place in a busy space on campus (e.g., Daltry & Mehr, 2015) or a grouped

environment with a heavy social influence (e.g., Adamle et al., 2009). However, as with all research, the study is not without its limitations. Many measures were used to measure depression, anxiety, stress and well-being, immediately after the CAI. This may be problematic as using a large number of measures in a single study increases the risk of study fatigue in participants, potentially make the findings less reliable. However, all participants completed the study in full, with no dropouts and no incomplete questions.

Further to the limitations discussed, there are a number of factors relating to participant involvement. As participants self-select to take part knowing they may have the opportunity to interact with a canine the sample may not represent a larger student population with less interest in canines. A similar issue presents with self-selected bias as participants who expressed the desire to interact with a canine were more likely to take part and participants in the control group may have faced disappointment at the lack of canine interaction. Additionally, the nature of the interaction was participant-led, potentially leading to a lack of consistency in the interactions across participants. Therefore, caution should be taken when drawing conclusions as to what about the interaction may have been effective. However, as toys and treats were not used, and petting and talking to the canine were the most common interactions, the range of interactions was not very broad. Future research using observational methods is required to determine the exact interaction levels to ascertain whether differing levels of interaction with the canine impacts the results. In addition the longevity of effects were not the focus of this study, therefore it is unclear how long the beneficial effect of CAI lasts. Longitudinal research is required to identify the durability of the effects.

Generalising the results should also be made with caution due to other contexts to CAI, such as AAI, often having the intervention facilitated by the researcher. Previous research has demonstrated that the social element of the interaction is important in ensuring an effective intervention (e.g., Adamle, et al., 2009; Dell et al., 2015). This study aimed to control and minimise the effects of social interaction. Therefore, the researcher remained uninvolved in the intervention in order to demonstrate that canine intervention is effective in its own right. An additional distinction to other contexts, such as AAI, is that the CAI in the current study did not have specific therapeutic goals defined before the intervention. The objective of the study was to identify how CAI can

benefit students in general rather than those with specific conditions as is often the case in AAI. Finally, only one canine was used, therefore results could be limited to this particular canine. Future research should utilize different canines to ensure the findings are not specific to the canine used here.

In conclusion, this study using randomized controlled trials provides support for CAI as an effective short-term intervention in reducing anxiety and stress in HE students. The results of this study positions CAI as a valid support system for HE students. The study also provides an effective paradigm to use for further research exploring specific parameters of what constitutes effective CAI.

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