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The Effectiveness of Individual and Group Canine-Assisted Interventions in Improving Mental Health in Higher Education Students

Karen Manville,¹ Mark Coulson,² and Gemma Reynolds³

Keywords: animal-assisted activities, canine-assisted intervention, HE students, mental health

Abstract The main aim of this study was to identify whether the social environment of canine-assisted intervention (CAI) influenced the beneficial effects on higher education (HE) students’ mental health. A second aim explored whether attachment style predicted the effect of being part of a CAI group. Sixty-seven participants interacted with a canine for two minutes, either individually, as part of a pair, or as a trio. Anxiety, stress, depression, and well-being were measured pre and post intervention, alongside attachment style. The results found no difference in the effectiveness of CAI when taking part individually, in pairs, or in a trio, meaning the social environment of CAI had no impact on the beneficial effects of CAI. Additionally, attachment style had no impact on the effectiveness of CAI when taking part in a trio. However, when taking part individually, a proximity seeking style predicted post depression, and in pairs, an insecure mistrust attachment style predicted post cheerfulness and feeling loved, and both insecure mistrust and proximity seeking styles predicted post confidence and relaxation. Overall, this study used a CAI group environment to explore the differences between taking part in CAI individually, in a pair, or as a trio in HE students and demonstrated that the social environment of CAI had no impact on its effectiveness in reducing anxiety, stress, and depression levels, or increasing well-being in the treatment group.

Mental health issues in higher education (HE) students, partly as a result of the COVID-19 pandemic, are on the rise (Kwong et al., 2021; Pierce et al., 2020). A number of studies have investigated the benefits of canine-assisted interventions (CAI) on the mental health of HE students (Binfet et al.,

2022; Rothkopf & Schworm, 2021; Silas et al., 2019; Spruin et al., 2020; see Manville et al., 2022a for a systematic review). This includes participants taking part in groups (e.g., Binfet et al., 2018; Binfet & Passmore, 2016 [groups of three or four students]; Dell et al., 2015 [no group numbers given]; Kivlen et al.,

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2022 [group of 27], Stewart et al., 2014 [groups of 10–15]; Trammell, 2017 [no group numbers given]; Wood et al., 2018 [groups of 6]). However, there are no studies that explore a direct comparison of CAI on a range of group numbers.

Binfet and Passmore (2016) randomly assigned participants to either a canine or a no treatment control group. In small groups of three or four the canine group took part in weekly sessions lasting 45 minutes over an 8-week period. The interaction activity was not specified. Measures were completed before and after canine intervention. The control group were instructed to carry on with their daily activities for the duration of the eight weeks. The results demonstrated that those in the canine group experienced a greater reduction in feelings of homesickness and a greater increase in satisfaction with life compared to the control group. Binfet et al. (2018) followed the same procedure; those in the canine group interacted with a canine in groups of three or four for an average of 35 minutes. They found that students experienced a significant reduction of stress. The intervention activity was not specified.

Similarly, Dell et al. (2015) had participants from three universities interact with a therapy dog. This took place over a 3-day period, either in groups or individually, and demonstrated that the therapy dog offered feelings of love and support. In Stewart et al.'s (2014) study, all participants interacted with a canine in a public place on campus. These sessions took part bimonthly over a 3-month period, and the results demonstrated there was a significant decrease in self-reported anxiety and feelings of loneliness post intervention.

However, these studies are not without limitations, the main being the CAI setting. In Dell et al.'s (2015) study there were a number of external factors that may have influenced the impact of CAI for participants, including food and hand massages, by enhancing participants' positive feelings about the situation and the interaction. In Stewart et al.'s (2014) study, data collection took place in a crowded public area, meaning the surrounding environment may have influenced the participants' experience by distracting them from the canine, possibly

enhancing or diminishing the effect of CAI. Additionally, the canines' focus and behavior may have been affected, which could have had an impact on results. This makes it difficult to determine whether the results were a direct influence of the canine or due to an external influence. While these issues do not detract from the benefits experienced by the students, the limitations make it difficult to categorically claim the positive benefits of CAI were a direct result of interacting with the canine and not from a combination of other external influences. In light of this, data collection in the current study will take place in a quiet and private space, in order to limit external influences.

A critical limitation of studies that explore CAI in a group setting is that there is no comparison made between how participants experience CAI, either individually or in groups (e.g., Adamle et al., 2009; Daltry & Mehr, 2015; McArthur & Syrynk, 2018; Wood et al., 2018). Additionally, there is no consideration as to what the effect of taking part in a group may have on the impact of CAI. The main aim of the current study is therefore to identify whether taking part in CAI in groups influences the beneficial effects of the intervention on HE student mental health compared to taking part individually. This study assigned participants to one of three groups depending on their availability. The interactions with the canine took place in a private lab on campus, and the main researcher was onsite to monitor the canine, manage the canine interaction sessions, and administer all pre and post intervention measures. In order to explore the effect of different interaction group sizes, participants in the individual CAI group interacted with a canine on their own, participants in the paired CAI group interacted with a canine and one other participant, and those in the trio CAI group interacted with a canine and two other participants. Participants were instructed to pet, play with, or watch the canine.

A second, and lesser aim of this study is to explore whether a vulnerable attachment style measured using the Vulnerable Attachment Style Questionnaire (VASQ, Bifulco et al., 2003) would affect the impact of group CAI. Research has demonstrated

that attachment style plays an important role in determining responses to social environments (e.g., Collins & Feeney, 2000). That is, individuals with an insecure mistrustful attachment style can experience unsatisfactory relationships (e.g., Honari & Saremi, 2015), while those with a high proximity seeking style have a diminished sense of self (e.g., Bacon & Conway, 2022) and may rely on others to fulfil their needs.

In order to explore these aims, the current study assigned participants to one of three groups. Manville et al. (2023) found that even a short 2-minute canine interaction, compared to 5 or 10 minutes, significantly reduced anxiety, stress, and depression compared to a control group. This has important implications in terms of resources, both physical and financial, in providing CAI in HE settings. Based on Manville et al.'s (2023) findings, participants completed pre and post measures immediately before and after interacting with a canine for 2 minutes. They were allocated to a group based on their availability. Participants in the individual CAI group interacted with a canine on their own, participants in the paired CAI group interacted with a canine and one other participant, and those in the trio CAI group interacted with a canine and two other participants. Using a randomized controlled trial, Manville et al. (2022b) demonstrated CAI to be responsible for the reduction of anxiety, stress, and depression compared to a no-treatment control group, so it was decided a no-interaction control group was not necessary for this study. Previous research (Binfet & Passmore, 2016; Binfet et al., 2018) demonstrated a social environment of groups of three or four participants had a positive impact on the mental health of HE students, therefore it is hypothesized in this research that the effect of social environment in the paired and trio CAI group will lead to a greater impact of CAI in reducing anxiety, stress, and depression, and an improvement in general well-being in HE students in comparison to the individual CAI group. However, it is unclear whether the trio group will experience a greater impact of CAI in comparison to the paired group. In relation to attachment style, it was hypothesized that participants with an insecure mistrustful attachment style would have a greater benefit from

interacting with CAI alone, and those with a high proximity seeking style would have a greater benefit from interacting with CAI in a group.

Method

Participants

Seventy-one undergraduate students from Middlesex University (63 females, 8 males) were assigned to one of three groups: individual CAI, paired CAI, or trio CAI. Of the 71 participants, four were excluded as they did not meet the age criteria. The age of the 67 students who took part ranged between 18 years to 25 years with a mean age of 20.69 years (SD = 2.10, female M = 20.76 years, SD = 2.01, male M = 20.13 years, SD = 2.75). The sample size was based on Cohen's (1988) recommended power of .80 power calculations to detect a medium effect size. Thirty-seven were of a White background, 2 of White and Black African or Caribbean, and 2 of White Asian mix. There were 6 of African, Caribbean, or any other Black background, 4 Arabs, 2 Chinese, 12 from any other background, and 2 chose not to state their ethnic background. Exclusion criteria included a fear of dogs, allergies to animals, and whether the participants had ever intentionally harmed an animal. All participants received either a £5 Amazon voucher or research credit toward their course requirement if they were a psychology student. Ethical approval was obtained from Middlesex University Psychology Research Ethics Committee (25/6/2019, application number 7916) and all participants gave written consent prior to the study commencing.

Materials

All data was collected using Qualtrics on 3 Amazon Fire HD 8 tablets (7th Generation). Dahlia (Figure 1), a Yorkshire Terrier Chihuahua cross that was employed for the CAI, frequently socializes with people other than her owner and enjoys the attention. Having successfully completed obedience training, she was with the researcher at all times and was monitored to ensure she was never in

fear or distress. To safeguard both canine and participant, Dahlia did not provide CAI for more than four 2-minute sessions a day and participated for the full 2 minutes. Additionally, she was made accustomed to her surroundings prior to data collection commencing. To ensure she was not overworked, Dahlia was given approximately 20–25 minutes' rest between CAI sessions. Dahlia interacted with participants in all three conditions (i.e., an individual, a pair of participants, and a trio of participants), with sessions scheduled for when participants were available. Dahlia's interaction with participants ranged from being petted by them, playing with them, or running around the lab in view of the participant/s. This duration lasted for the full 2 minutes of each data collection session. While participants were completing the questionnaires, Dahlia was monitored by the researcher in a separate area of the lab, not in view of the participant/s. Once measures were completed, the researcher released Dahlia to interact with participants. Once the interaction time was over, Dahlia was placed back into the separated area.



Figure 1. Dahlia the dog.

Questionnaire Measures

Two standardized questionnaires were used. The Vulnerable Attachment Style Questionnaire (VASQ) (Bifulco et al., 2003) was used to measure attachment style. The Personal Well-Being Index (PWI, International Wellbeing Group, 2013) was used to measure well-being.

The VASQ, used to measure attachment style, consists of two factors: insecurity mistrust and degree of proximity seeking. Example items include *people let me down a lot*, *I get anxious when people close to me are away*, and *having people around me can be a nuisance*. Scores range from 22 to 110 for the overall measure, 12–60 for insecure mistrust, and 10–50 for degree of proximity seeking. Internal consistency was found to be acceptable for the total scores on the VASQ, Cronbach's $\alpha = .79$, and degree of proximity seeking $\alpha = .72$, and high for insecurity mistrust, $\alpha = .83$.

The PWI was used as a standardized measure to assess participants' well-being. Example questions include *how satisfied are you with your standard of living* and *how satisfied are you with how safe you feel*. The optional questions were not included to prevent extending the overall length of the questionnaires in the study. The final measure used consisted of seven questions resembling a VAS with *no satisfaction at all* at one end and *completely satisfied* at the other. Reliability was high pre intervention, Cronbach's $\alpha = .82$, and post intervention $\alpha = .87$.

Three visual analogue scales (VAS; see Manville et al., 2022b) were used to measure anxiety, stress, and depression. Participants were asked to indicate how they felt at that current moment in time on a 10-point scale with, for example, *very anxious* at one end and *not anxious at all* at the other. Five additional visual analogue scales were used to measure particular elements of well-being. The VAS was based on five elements of well-being (optimism, confidence, cheerfulness, relaxation, feeling loved) that complement Rath and Harter's (2010) work. Participants indicated on a 10-point scale where their feelings in relation to the five elements were best represented (see Appendix A for the full VAS).

Additionally, a demographics questionnaire was used to obtain details about the participants' age, gender, and ethnicity (see Appendix B).

Procedure

Data collection was carried out using prearranged appointments and took place in a lab on campus at Middlesex University. Participants were assigned to one of the three groups: the Individual CAI group ($n = 21$), the Paired CAI group ($n = 22$), or the Trio CAI group ($n = 24$). Participants were able to book a CAI session either on their own, with a friend/s to make groups of two or three, or they were assigned to a CAI group. The total duration of the study (pre intervention measures, CAI, and post intervention measures) took approximately 30 minutes.

A demographics questionnaire was first completed by all participants once it was confirmed they met the inclusion criteria and had signed a consent form. Participants were also asked whether they liked canines on a 5-point scale ranging from *like dogs* to *dislike dogs*.

Pre intervention: Measures were presented to all three groups in the same order: VASQ, VAS-Anxiety, VAS-Stress, VAS-Depression, VAS-Optimism, VAS-Confidence, VAS-Cheerfulness, VAS-Relaxation, VAS-Feeling Loved, and PWI (Manville et al., 2022b, 2023). The canine was out of sight of all participants during pre intervention measures.

Intervention: Participants chose to take part either individually, as a pair, or as a trio. If participants were unable to bring a friend, they were assigned where required. Once all measures were completed, the canine was presented to the participants. All groups interacted with the canine for 2 minutes (petting, playing with, or watching the canine), which was monitored by the researcher using a stopwatch. As soon as the 2-minute marker was reached, Dahlia was removed from the lab. Participants in the Individual CAI group interacted on their own with the canine. Participants in the Paired CAI group interacted with the canine with one other participant, and those in the Trio CAI groups interacted with the canine with two other participants. Participants were informed the

researcher would stay in the room during the session but would not take part in the intervention. CAI sessions took place in the same room with no other interactions or influences such as other persons on site. In all three groups the participants dictated the level and form of interaction with the canine. Other than asking participants not to pick up or do anything that would harm the canine, there were no boundaries in the interaction between canine and human. Participants were instructed they could pet, play with, simply watch, or even run around the lab with the dog.

Post intervention: All groups completed post intervention measures in the same order as pre intervention: VASQ, VAS-Anxiety, VAS-Stress, VAS-Depression, VAS-Optimism, VAS-Confidence, VAS-Cheerfulness, VAS-Relaxation, VAS-Feeling Loved, and PWI (Manville et al., 2022b, 2023). All participants were fully debriefed once post intervention measures had been completed. Finally, participants were given the opportunity to ask the researcher any questions about the study or the canine.

Results

Statistical Analysis

Correlation analyses were first conducted to check concordance between measures pre intervention (Table 1) and post intervention (Table 2). In order to explore whether the social environment had an influence on the mental health and well-being outcomes of CAI in the individual CAI group, the paired CAI group, and the trio CAI group, two-way 3(group: individual CAI group, paired CAI group, trio CAI group) $\times$ 2(phase: pre vs. post) mixed ANOVAs (between groups on the group variable and within subjects on the phase variable) were performed on anxiety, stress, depression, optimism, confidence, cheerfulness, relaxation, feeling loved, and personal well-being scores. Alpha = 0.05 was set as the rejection criterion in all analyses; the effect size is reported as partial eta-squared (η^2_p).

To explore the relationship between CAI and attachment style, a hierarchical regression was carried out to explore whether pre intervention VAS-Anxiety

Table 1. Correlation between All Measures at Pre Intervention

Variables	VAS-Anxiety	VAS-Stress	VAS-Depression	VAS-Optimism	VAS-Confidence	VAS-Cheerfulness	VAS-Relaxation	VAS-Feeling Loved	PWI
VAS-Anxiety	—								
VAS-Stress	.81**	—							
VAS-Depression	.66**	.69**	—						
VAS-Optimism	-.23	-.24	-.38**	—					
VAS-Confidence	-.27*	-.23	-.22	.51**	—				
VAS-Cheerfulness	-.27*	-.30*	-.40**	.55**	.54**	—			
VAS-Relaxation	-.33**	-.45**	-.37**	.50**	.64**	.59**	—		
VAS-Feeling Loved	.03	-.16	-.26*	.45**	.26*	.35**	.42**	—	
PWI	-.33**	-.25*	-.42**	.31*	.43**	.38**	.50**	.41**	—

* $p < .05$, ** $p < .01$, *** $p < .001$ **Table 2.** Correlation between All Measures at Post Intervention

Variables	VAS-Anxiety	VAS-Stress	VAS-Depression	VAS-Optimism	VAS-Confidence	VAS-Cheerfulness	VAS-Relaxation	VAS-Feeling Loved	PWI
VAS-Anxiety	—								
VAS-Stress	.82**	—							
VAS-Depression	.66**	.53**	—						
VAS-Optimism	-.17	-.13	-.14	—					
VAS-Confidence	-.29*	-.35**	-.18	.39**	—				
VAS-Cheerfulness	-.17	-.28*	-.14	.59**	.63**	—			
VAS-Relaxation	-.30*	-.38**	-.18	.38**	.67**	.74**	—		
VAS-Feeling Loved	-.23	-.23	-.20	.45**	.35*	.55**	.48**	—	
PWI	-.39*	-.32**	-.37**	.33**	.47**	.40**	.57**	.41**	—

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

(model 1), VASQ Insecurity Mistrust (model 2), and VASQ Proximity Seeking (model 3) were significant predictors of anxiety, stress, depression, and general well-being. This hierarchical regression was repeated on all other VAS measures (stress, depression, optimism, confidence, cheerfulness, relaxation, feeling loved) and the PWI.

Preliminary Analysis

To explore whether participants' feelings toward canines had an impact on CAI, participants were asked if they liked dogs. A one-way ANOVA was performed on all groups, and the results found no significant difference between groups as demonstrated by a one-way ANOVA $F(2,62) = 1.82, p = .17$.

Preexisting Differences

A one-way ANOVA was carried out on all pre measure scores (VAS-Anxiety, VAS-Stress, VAS-Depression, VAS-Optimism, VAS-Confidence, VAS-Cheerfulness, VAS-Relaxation, VAS-Feeling Loved, and the PWI) to check for any preexisting differences before the intervention. No significant preexisting differences in these measures were found.

Correlation Analyses

A series of correlations were carried out pre intervention (Table 1) and post intervention (Table 2). Anxiety, stress, and depression were strongly correlated throughout, and the facets of well-being (optimism, confidence, cheerfulness, relaxation, and feeling loved) were also highly correlated. While the domains of anxiety, stress, and depression were less well correlated with the facets of well-being, all were highly correlated with the PWI.

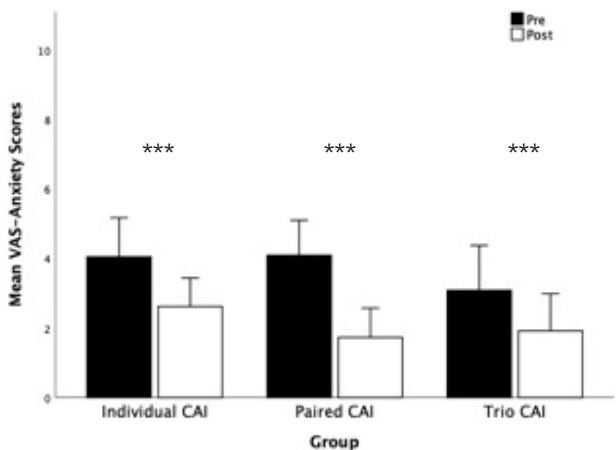
Anxiety

Figure 2 displays the mean VAS-Anxiety scores, pre and post intervention in the individual CAI, paired CAI, and trio CAI groups and shows a reduction

in anxiety from pre intervention to post intervention in all three groups with the greatest reduction in the paired group. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 43.65, p < .001, \eta^2_p = .41$ (95% CIs [0.22, 0.54]), but no significant main effect of group, $F(2, 64) = 0.83, p = .44, \eta^2_p < .03$ (95% CIs [0.00, 0.12]) and no significant phase × group interaction, $F(2, 64) = 2.13, p = .13, \eta^2_p = .06$ (95% CIs [0.00, .018]), indicating anxiety levels were lowered regardless of group. Results therefore demonstrate that CAI was effective in reducing anxiety from pre to post intervention, regardless of whether participants took part in CAI as an individual, in a pair, or in a trio.

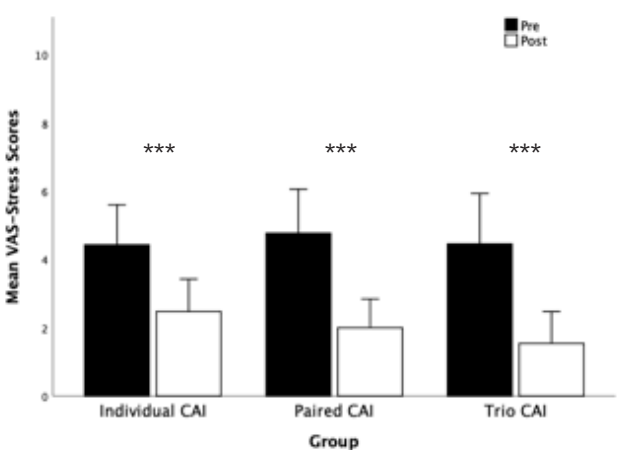
Stress

Figure 3 shows a reduction in VAS-Stress scores in all three groups from pre to post intervention with the largest reduction in the trio group. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 56.53, p < .001, \eta^2_p = .47$ (95% CIs [0.29, 0.60]). There was no significant main effect of group, $F(2, 64) = 0.28, p = .76, \eta^2_p < .009$ (95% CIs [0.00, 0.07]) and no significant phase × group interaction, $F(2, 64) = 0.77, p = .47, \eta^2_p = .02$ (95% CIs [0.00, 0.11]), indicating that regardless of group, stress



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

Figure 2. Pre and post mean VAS-Anxiety scores (with SE bars) for individual CAI, paired CAI, and trio CAI groups.



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

Figure 3. Pre and post mean VAS-Stress scores (with SE bars) for individual CAI, paired CAI, and trio CAI groups.

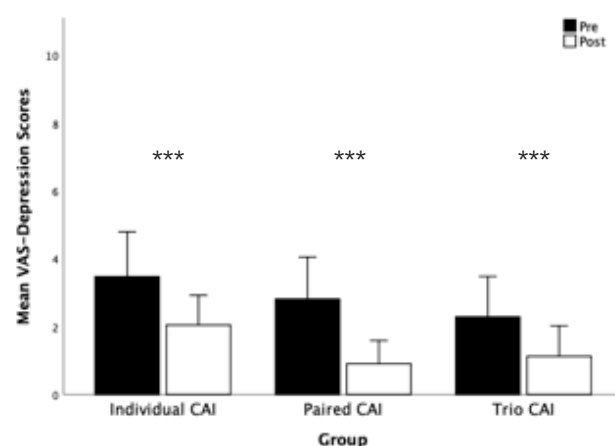
levels were significantly reduced. Therefore, similar to the results of the VAS-Anxiety, regardless of how participants experienced CAI (individually, in pairs, or in a trio), CAI reduced stress levels from pre to post intervention.

Depression

VAS-Depression scores are shown in Figure 4. All three groups experienced a reduction in depression with a greater reduction in the paired and trio groups. The 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 41.85, p < .001, \eta^2_p = .40$ (95% CIs [0.21, 0.53]), but no significant main effect of group, $F(2, 64) = 1.43, p = .25, \eta^2_p = .04$ (95% CIs [0.00, 0.15]) and no significant phase × group interaction, $F(2, 64) = 0.90, p = .41, \eta^2_p = .03$ (95% CIs [0.00, .012]), indicating a reduction in depression regardless of group. In line with both the VAS-Anxiety and VAS-Stress results, the findings demonstrate depression levels were reduced post intervention, regardless of whether participants experienced CAI individually, in a pair, or in a trio.

Visual Analogues Scales: Well-Being

Optimism. Table 3 shows pre and post intervention mean scores for the three groups indicating an



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

Figure 4. Pre and post mean VAS-Depression scores (with SE bars) for individual CAI, paired CAI, and trio CAI groups.

increase in optimism pre to post intervention in all three groups, with the greatest increase in the paired and trio groups. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 31.51, p < .001, \eta^2_p = .33$ (95% CIs [0.15, 0.48]), but no significant main effect of group, $F(2, 64) = 1.49, p = .23, \eta^2_p = .05$ (95% CIs [0.00, 0.15]) and no significant phase × group interaction, $F(2, 64) = 0.06, p = .94, \eta^2_p = .002$ (90% CIs [0.00, 0.04]). Therefore, results show that regardless of group (individual CAI, paired CAI, or trio CAI) there was an increase in optimism from pre to post intervention.

Confidence. Table 3 displays the mean VAS-Confidence scores pre to post intervention in all three groups showing confidence levels increase pre to post intervention in all three groups. However, whereas the greatest increase was seen in the paired and trio groups in the VAS-Optimism, the greatest increase in the VAS-Confidence was found in the individual and trio groups. The 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 22.66, p < .001, \eta^2_p = .26$ (95% CIs [0.09, 0.42]) but no significant main effect of group, $F(2, 64) = 2.89, p = .06, \eta^2_p = .08$ (95% CIs [0.00, 0.21]) and no significant phase × group interaction, $F(2, 64) = 0.38, p = .68, \eta^2_p = .01$ (95% CIs [0.00, 0.09]), demonstrating CAI was effective in increasing confidence levels regardless of whether participants experienced CAI individually, in pairs, or in a trio.

Cheerfulness. The increase in cheerfulness levels (Table 3) differs from both the VAS-Optimism and Confidence in that the greatest increase in cheerfulness was seen in the paired and individual groups, although cheerfulness levels from pre to post intervention did increase in all groups. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 62.09, p < .001, \eta^2_p = .49$ (95% CIs [0.31, 0.61]) and a significant main effect of group, $F(2, 64) = 3.77, p = .03, \eta^2_p = .11$ (95% CIs [0.00, 0.24]). Crucially, there was no significant phase × group interaction, $F(2, 64) = 0.07, p = .93, \eta^2_p = .002$ (95% CIs [0.00, 0.04]), indicating that regardless of group (individual, paired, or trio) CAI was

Table 3. Pre and Post Intervention Mean Scores and SD for the Individual CAI Group, the Paired CAI Group, and the Trio CAI Group for VAS-Optimism, VAS-Confidence, VAS-Cheerfulness, VAS-Relaxation, and VAS-Feeling Loved

VAS-Optimism		M	SD
Individual CAI group***	Pre	4.71	2.26
	Post	6.19	1.75
Paired CAI group***	Pre	5.73	2.68
	Post	7.41	2.06
Trio CAI group***	Pre	5.13	2.47
	Post	6.83	3.02
VAS-Confidence		M	SD
Individual CAI group***	Pre	4.24	2.26
	Post	5.52	1.75
Paired CAI group***	Pre	6.00	2.60
	Post	6.95	2.50
Trio CAI group***	Pre	5.46	2.87
	Post	6.96	3.07
VAS-Cheerfulness		M	SD
Individual CAI group***	Pre	4.33	2.44
	Post	6.90	1.61
Paired CAI group***	Pre	5.73	2.23
	Post	8.32	1.99
Trio CAI group***	Pre	5.75	2.67
	Post	8.08	2.47
VAS-Relaxation		M	SD
Individual CAI group***	Pre	3.19	1.89
	Post	5.90	2.12
Paired CAI group***	Pre	4.86	2.64
	Post	7.50	2.20
Trio CAI group***	Pre	4.46	3.16
	Post	7.92	2.73
VAS-Feeling Loved		M	SD
Individual CAI group***	Pre	5.14	2.50
	Post	7.62	1.96
Paired CAI group***	Pre	5.91	3.04
	Post	8.00	2.33
Trio CAI group***	Pre	4.58	3.06
	Post	7.04	3.11

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

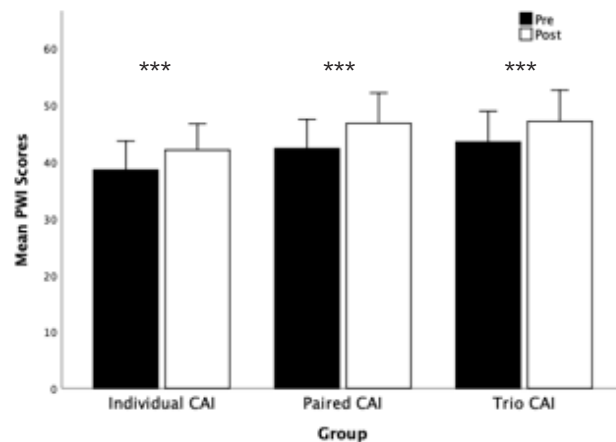
effective at increasing levels of cheerfulness pre to post intervention.

Relaxation. Table 3 shows the mean pre to post intervention scores for the VAS-Relaxation. Relaxation increases in all three groups; however, the greatest increase is seen in the trio and paired groups, which is similar to those of the VAS-Confidence. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 74.71, p < .001, \eta^2_p = .54$ (95% CIs [0.37, 0.65]) and a significant main effect of group, $F(2, 64) = 4.38, p = .02, \eta^2_p = .12$ (95% CIs [0, 0.26]), but no significant phase × group interaction, $F(2,64) = 0.62, p = .55, \eta^2_p = .02$ (95% CIs [0.00, 0.10]). The findings therefore show an increase in relaxation from pre to post intervention regardless of whether participants took part in CAI individually, in pairs, or in a trio.

Feeling Loved. Table 3 displays the mean VAS-Feeling Loved scores in all groups from pre to post intervention, demonstrating an increase in levels of feeling loved with the greatest increase seen in the individual and trio groups. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 43.17, p < .001, \eta^2_p = .40$ (95% CIs [0.22, 0.54]) but no significant main effect of group, $F(2, 64) = 1.42, p = .25, \eta^2_p = .04$ (95% CIs [0.00, 0.15]), and no significant phase × group interaction, $F(2,64) = 0.12, p = .88, \eta^2_p = .004$ (95% CIs [0, 0.06]). Therefore, regardless of whether participants experienced CAI individually, in pairs, or in a trio, there was an increase in levels of feeling loved pre to post intervention.

Personal Well-Being Index

Figure 5 displays an increase in pre to post well-being levels in all three groups as measured by the PWI. A 3×2 mixed ANOVA revealed a significant main effect of phase, $F(1, 64) = 18.75, p < .001, \eta^2_p = .23$ (95% CIs [0.07, 0.38]) but no significant main effect of group, $F(2, 64) = 1.23, p = .30, \eta^2_p = .04$ (95% CIs [0.00, 0.14]), and no significant phase × group interaction, $F(2, 64) = 0.10, p = .95, \eta^2_p = .003$ (90%



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

Figure 5. Pre and post mean PWI scores (with SE bars) for individual CAI, paired CAI, and trio CAI groups.

CIIs [0, 0.05]. Therefore, there was an increase in well-being levels regardless of how participants took part in CAI (individually, in pairs, or in a trio).

Vulnerable Attachment Style Questionnaire

The enter method was used to carry out a three-stage hierarchical regression to explore whether the VASQ-Insecurity Mistrust and VSQ-Proximity Seeking were significant predictors of post measures (VAS-Anxiety, Stress, Depression, Optimism, Confidence, Cheerfulness, Relaxation, Feeling Loved, and PWI). Only significant results are reported.

Individual CAI Group.

Depression. In the first step of hierarchical regression, three predictors were entered: pre intervention anxiety, pre intervention stress, and pre intervention depression to predict post intervention depression resulting in acceptable variance inflation factor (VIF) scores. This model was statistically significant, $F(3, 17) = 17.07, p < .001$ and explained 75% of variance in post intervention depression. Only pre intervention depression scores made a significant unique contribution to the model; pre intervention anxiety and pre intervention stress did not. After

entry of VASQ Insecurity Mistrust in model 2, the total variance explained by the model as a whole was 75%, $F(4,16) = 12.24, p < .001$. The introduction of VASQ Insecurity Mistrust explained an additional .03% of variance in post intervention depression. After entry of VASQ Proximity Seeking in model 3, the total variance explained by the model as a whole was 88%, $F(5,15) = 21.73, p < .001$. The introduction of VASQ Proximity Seeking explained an additional 13% of variance in post intervention depression. After controlling for pre intervention anxiety, pre intervention stress, and pre intervention depression this change in R^2 was significant, $F(1,15) = 15.45, p = .001$. The final adjusted model demonstrated that only VASQ Proximity Seeking was statistically significant ($\beta = -.37, p = .001$), indicating that only the VASQ Proximity Seeking was a significant predictor of post intervention depression.

Paired CAI Group.

Confidence. A hierarchical regression was carried out for post intervention confidence with four predictors: pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention confidence. The equation resulted in acceptable VIF scores. The model was statistically significant, $F(4,17) = 7.67, p = .001$ and explained 64% of variance in post intervention confidence. Pre intervention confidence, pre intervention anxiety, pre intervention stress, and pre intervention depression did not make a significant unique contribution to the model. VASQ Insecurity Mistrust was entered into model 2, which increased the total variance explained by the model as a whole to 76%, $F(5,16) = 10.10, p < .001$. Introducing VASQ Insecurity Mistrust explained an additional 12% of variance in post intervention confidence. VASQ Proximity Seeking was entered into model 3, which increased the total variance explained by the model as a whole to 84%, $F(6,15) = 13.30, p < .001$. The introduction of VASQ Proximity Seeking explained an additional 8% of variance in post intervention confidence. After controlling for pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention confidence, results demonstrated the

change in R^2 was significant, $F(1,15) = 7.80, p = .01$. The final adjusted model demonstrated that both the VASQ Insecurity Mistrust ($\beta = -.44, p = .003$) and the VASQ Proximity Seeking ($\beta = -.32, p = .01$) were significant, indicating that both the VASQ Insecurity Mistrust and VASQ Proximity Seeking were significant predictors of post intervention confidence.

Cheerfulness. Four predictors were entered to predict post intervention cheerfulness: pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention cheerfulness with the equation presenting acceptable VIF scores. The model was not statistically significant, $F(4,17) = .23, p = .92$ and explained 5% of variance in post intervention cheerfulness. Only pre intervention cheerfulness scores made a significant unique contribution to the model: pre intervention anxiety, pre intervention stress, and pre intervention depression did not. VASQ Insecurity Mistrust was entered into model 2, increasing the total variance explained by the model as a whole to 31%, $F(6,15) = 1.42, p = .27$. Introducing VASQ Insecurity Mistrust explained an additional 26% of variance in post intervention cheerfulness. After entry of VASQ Proximity Seeking in model 3, the total variance explained by the model as a whole was 39%, $F(6,15) = 1.61, p = .21$. The introduction of VASQ Proximity Seeking explained an additional 9% of variance in post intervention cheerfulness. After controlling for pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention cheerfulness, results found the change in R^2 was significant, $F(1,15) = 2.09, p = .17$. Results of the final adjusted model demonstrated that only VASQ Insecurity Mistrust ($\beta = -.60, p = .03$) was significant, indicating that the VASQ Insecurity Mistrust was a significant predictor of post intervention cheerfulness.

Relaxation. A hierarchical regression was carried out for post intervention relaxation with four predictors: pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention relaxation. The equation resulted in acceptable VIF scores. This model was not statistically significant, $F(4,17) = 2.13, p = .12$ and explained 33% of

variance in post intervention relaxation. Only pre intervention relaxation scores made a significant unique contribution to the model: pre intervention anxiety, pre intervention stress, and pre intervention depression did not. VASQ Insecurity Mistrust was entered into model 2, which increased the total variance explained by the model as a whole to 48%, $F(5,16) = 2.95, p = .05$. Introducing VASQ Insecurity Mistrust explained an additional 15% of variance in post intervention relaxation. VASQ Proximity Seeking was entered into model 3, which increased the total variance explained by the model as a whole to 64%, $F(6,15) = 4.52, p = .008$. The introduction of VASQ Proximity Seeking explained an additional 16% of variance in post intervention relaxation. After controlling for pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention relaxation, results demonstrated the change in R^2 was significant, $F(1,15) = 0.16, p = .02$. The final adjusted model demonstrated that both the VASQ Insecurity Mistrust ($\beta = -.47, p = .02$), and VASQ Proximity Seeking were significant ($\beta = -.41, p = .02$). These results indicate that the VASQ Insecurity Mistrust and VASQ Proximity Seeking were significant predictors of post intervention relaxation.

Feeling Loved. A final hierarchical regression was carried out for post intervention feeling loved with four predictors: pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention feeling loved. The equation resulted in acceptable VIF scores. This model was statistically significant, $F(4,17) = 7.13, p = .001$ and explained 63% of variance in post intervention feeling loved. Pre intervention feeling loved, pre intervention anxiety, and pre intervention depression scores made a significant unique contribution to the model; pre intervention stress did not. VASQ Insecurity Mistrust was entered into model 2, which increased the total variance explained by the model as a whole to 75.1%, $F(5,16) = 9.63, p = <.001$. Introducing VASQ Insecurity Mistrust explained an additional 13% of variance in post intervention feeling loved. After entry of VASQ Proximity Seeking in model 3, the total variance explained by the model as a whole was 75.3%, $F(6,15) = 7.61, p = .001$. The introduction of

VASQ Proximity Seeking explained an additional .02% of variance in post intervention feeling loved. After controlling for pre intervention anxiety, pre intervention stress, pre intervention depression, and pre intervention feeling loved, results demonstrated the change in R^2 was significant, $F(1,15) = .12$, $p = .73$. The final adjusted model demonstrated that only the VASQ Insecurity Mistrust was significant ($\beta = -.42$, $p = .02$), indicating that the VASQ Insecurity Mistrust was a significant predictor of post intervention feeling loved.

The overall findings indicate that for the individual CAI group, the VASQ Proximity Seeking was a significant predictor of post intervention depression. In the paired group, the VASQ Insecurity Mistrust was a significant predictor of post intervention cheerfulness and post intervention feeling loved. Additionally, both the VASQ Insecurity Mistrust and VASQ Proximity Seeking were significant predictors of post intervention confidence and post intervention relaxation. All other measures including results from the trio CAI group demonstrated no significant regression equations.

Discussion

This study expands previous research that investigated CAI in a group setting (Binfet et al., 2018; Trammell, 2017; Wood et al., 2018) by exploring whether the human to canine ratio has an impact on the effectiveness of CAI on self-reported levels of anxiety, stress, depression, and well-being in HE students. The findings demonstrate that regardless of how participants experienced CAI (individually, as a pair, or as a trio), a short, 2-minute CAI was effective in reducing anxiety, stress, and depression in HE students, while also increasing well-being, including feelings of optimism, confidence, cheerfulness, relaxation, and feeling loved. The findings also demonstrated that attachment style did not predict post CAI levels of anxiety, stress, optimism, or well-being, nor did it predict any post levels when participants took part in CAI in a trio. In those who

took part in CAI individually, having a proximity seeking style predicted post intervention depression. For those who took part in CAI in pairs, having an insecure mistrustful attachment style predicted post intervention cheerfulness and feeling loved, and finally both the insecure mistrust and proximity seeking styles predicted post intervention confidence and relaxation.

While there is an abundance of research demonstrating benefits to the mental health of HE students receiving CAI individually (Buttelmann & Römpke, 2014; Crossman et al., 2015; Delgado et al., 2018; Fiocco & Hunse, 2017; Grajfoner et al., 2017; Hall, 2018; Jarolmen & Patel, 2018), as well as in groups (Binfet & Passmore, 2016; Crump & Derting, 2015; Daltry & Mehr, 2015; Dell et al., 2015; Shearer et al., 2016; Trammell, 2017; Wood et al., 2018), to the authors' knowledge, this is the first study to directly compare individual CAI to group CAI. Crucially, mental health and well-being benefits were evident whether individuals participated in the CAI alone, in a pair, or in a group of three, with no specific advantage to any of the social environments.

The finding that adding a social element to CAI through group participation has no effect on the impact of CAI goes against previous research that suggests social interaction is a direct contributing factor for successful CAI (e.g., Adamle et al., 2009; Binfet & Passmore, 2016; Binfet, 2017). Instead, it seems to be that the act of interacting with a canine is the key factor in determining the effectiveness of CAI, not the social interaction with other humans during the intervention. Although there was an increase in all five elements of well-being, it is interesting that there was a significant increase in cheerfulness and relaxation regardless of how participants took part (individually, as a pair, or as a trio) in comparison to the other elements of well-being (optimism, confidence, feeling loved).

Another interesting finding is the results of attachment style in response to CAI. That those with high proximity seeking found taking part in CAI individually predicted post intervention depression levels contradicts the belief that those with proximity

seeking styles are generally more dependent in nature and dislike being alone. There were also conflicting results found in those who took part in pairs. As expected, those with proximity seeking attachment styles who experienced CAI in pairs predicted relaxation and confidence. However, for those who took part in pairs, their insecure mistrust attachment styles predicted cheerfulness and confidence, which contradicts the expectation that they would respond better to experiencing CAI on their own. Finally, those with neither attachment style benefited from taking part in CAI in groups of three, which is unexpected given that those with proximity seeking styles were expected to benefit from CAI in a trio.

It is difficult to understand why the results do not follow what is known of attachment styles and how persons with individual styles prefer to interact with others. This may be because the study did not first determine participant attachment styles and then allocate them to the group that would best suit them. One possibility is that attachment style has very little bearing on the impact of CAI in relation to anxiety, stress, depression, and well-being. VIF values for the regression were also flagged as a possible issue as they were acceptable; however, the VIF for all regressions did not exceed values where multicollinearity may be an issue (Field, 2005). However, there was an issue with the variance results reported for the VASQ depression. It is possible this is due to the small sample size; however, it is far more likely this stems from strong correlations between the independent variables resulting in multicollinearity. It is important to note that attachment style was a lesser aim of the study, therefore future research is required to explore attachment styles in CAI in more depth. In addition, this study only focused on proximity seeking and insecure mistrustful attachment styles. Future research should look more explicitly at attachment styles, including secure attachment.

As with all research, this study comes with its limitations. As the study used only one canine, Dahlia, who is generally considered cute (see Figure 1) due to her size (40 cm in length, 20 cm in height, or approximately the size of a large butternut squash), it

is possible that results may be limited to smaller or cuter canines (or Dahlia herself). It is also important to note that while previous research (Manville et al., 2023) has used the same questionnaires within short durations and reports encouraging results, more research is required to validate them for use in such short time scales.

The second issue with the methodology is that the maximum group size in the study was a group of three participants. Previous research (e.g., Crump & Derting, 2015; Wood et al., 2018) used groups of six, while other studies (e.g., Shearer et al., 2016; Stewart et al., 2014) used groups as large as 10–15. It is possible that larger groups may be more likely to yield greater effectiveness of CAI and would have greater implications for practical and financial reasons.

An additional limitation relates to participants taking part in groups with friends compared to those who interacted with the canine as part of a pair or trio. Those who participated with friends arrived with existing relationships and may have already been comfortable together in comparison to those who may have spent the first few moments introducing themselves to each other. This may have had an impact on CAI and how this was received and experienced. However, due to the nature of recruitment, asking participants to book with a friend was a favorable way to secure participants.

One strength of this study is the finding that there is no differential effect on anxiety, stress, depression, or well-being levels whether participants took part in CAI individually, in a pair, or as a trio. This study follows a similar structure to Manville et al. (2023) who demonstrated reductions in anxiety, stress, and depression regardless of whether the interaction was 2, 5, or 10 minutes in duration. Based on this, more students can take advantage of CAI in a set time period, which has significant implications for costs and resources. This will hopefully make CAI more appealing to universities as a less traditional form of support.

In conclusion, this study used a between subject design comparing the impact of CAI on participants who took part individually, in a pair, or as part of a

trio. The results support previous research in a HE population that has determined CAI has a positive impact on anxiety (Buttelmann & Römpke, 2014; Lass-Hennemann, et al., 2018), stress (Delgado et al., 2018; Fiocco & Hunse, 2017), and depression (Manville et al., 2023). In addition, this study demonstrates that there is no impact of a social environment on the benefits of CAI on the mental health of HE students, specifically on anxiety, stress, depression, and well-being. These results help to elevate CAI as a valid support system for universities to support HE students experiencing anxiety, stress, and depression, while also improving their levels of well-being.

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APPENDIX A

VAS Scales

Visual Analogue Scales

The following questions ask how you feel on a scale from *very* or *low* to *not very* or *high*.

Please indicate where on the line you feel best represents how you **currently** feel.

1. Anxiety. Please indicate your current level of anxiety.

Very anxious

Not anxious at all

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2. Stress. Please indicate your current level of stress.

Very stressed

Not stressed at all

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3. Depression. Please indicate your current level of depression.

Very depressed

Not depressed at all

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4. Optimism. How optimistic do you currently feel about your life in general?

Very optimistic

Not optimistic at all

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5. Confidence. How much confidence do you currently have in yourself?

Low confidence

High confidence

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6. Cheerfulness. How cheerful do you currently feel?

Very cheerful

Not very cheerful

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7. Relaxation. How relaxed do you currently feel?

Very relaxed

Not very relaxed

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8. Feeling loved. How loved do you currently feel?

Very loved

Not very loved

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APPENDIX B

Demographics Questionnaire

Canine-Assisted Interaction—Demographics Questionnaire

Please complete the following questions.

- 1. What is your date of birth?
- 2. Are you male or female?
- 3. Please specify your ethnicity.
 - 1. White 1. English / Welsh / Scottish / Northern Irish / British
 - 2. Irish
 - 3. Gypsy or Irish Traveller
 - 4. Any other White background, please describe Mixed / Multiple ethnic group
 - 5. White and Black Caribbean
 - 6. White and Black African
 - 7. White and Asian
 - 8. Any other Mixed / Multiple ethnic background, please describe Asian / Asian British
 - 9. Indian
 - 10. Pakistani
 - 11. Bangladeshi
 - 12. Chinese
 - 13. Any other Asian background, please describe Black / African / Caribbean / Black British
 - 14. African
 - 15. Caribbean
 - 16. Any other Black / African / Caribbean background, please describe any other ethnic group
 - 17. Arab
 - 18. Any other ethnic group, please describe