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Influence of Interactive Behaviors Induced by a Therapy Dog and Her Handler on the Physiology of Residents in Nursing Homes: An Exploratory Study

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ABSTRACT

The aim of this exploratory study was to investigate interactive behaviors performed between residents at nursing homes and a therapy dog and her handler and explore if they influenced residents' physiological variables such as fingertip temperature, heart rate, and systolic and diastolic blood pressure. The therapy dog–handler team visited 12 older people at three nursing homes for 60 min twice a week during a four-week period. The visits were videotaped, and the duration of interactive behaviors was recorded. The physiological variables were measured before (0 min) and after (60 min) the interaction between the residents and the dog–handler team, and the delta value was calculated. The interactive behaviors during the first two and the last two weeks were as follows: the resident looking at the dog (799 and 697 s/h), the resident in physical contact with the dog (183 and 109 s/h, $p < 0.001$, Wilcoxon signed-rank test), the resident playing with the dog (123 and 126 s/h), the resident talking with others (559 and 511 s/h), and the dog handler having physical contact with the resident (822 and 764 s/h). The mean values for fingertip temperature, heart rate, and systolic and diastolic blood pressure did not differ significantly between the first and two last weeks (paired *t*-test). However, the delta values varied largely between the different residents. The more physical contact the residents had with the dog handler, the more the fingertip temperature increased ($p < 0.05$, mixed linear model). The duration of physical contact between the residents and the dog tended to be associated with an increased fingertip temperature ($p < 0.1$). Furthermore, the more the residents were in verbal contact with the dog handler, the more their heart rate decreased ($p < 0.05$). These results demonstrate some associations between specific interactive behaviors and physiological changes in residents in connection with visits by a dog–handler team.

KEYWORDS
Human–animal interaction; nursing home; physiological changes; sympathetic nervous system; therapy dog

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Older people may, at a later stage of their life, be forced to live in a nursing home to receive daily support and attendance. These residents often have health issues; high blood pressure and anxiety are common (Krause-Parello & Kolassa, 2016).

Studies show that interactions with dogs can decrease systolic blood pressure and heart rate (Barker & Wolen, 2008; Beetz et al., 2012; Cole et al., 2007; Handlin et al., 2018), feelings of stress (Krause-Parello et al., 2019; Maujean et al., 2015), and depression in older people (Le Roux & Kemp, 2009; Olsen et al., 2016; Souter & Miller, 2007). Olsen et al. (2016) also showed that quality of life increased in older people living in nursing homes after meeting a therapy dog.

Several senses are involved when humans interact with dogs: eye contact with the dog, talking with the dog, listening to and also petting and caressing the dog. All these involve the stimulation of sensory nerves, which is an important part of the interaction. It has been shown that when dogs gaze at their owners who gaze back during social interaction, owners' urinary oxytocin levels increase (Nagasawa et al., 2009, 2015). A therapy dog may affect nursing home residents in a similar way if it is perceived as a positive interaction.

Fingertip temperature, heart rate, and blood pressure are all regulated by the autonomic nervous system (Kistler et al., 1998). During stress, the sympathetic nervous system activity (sympathetic tone) increases, which leads to an increase in heart rate and blood pressure. In addition, peripheral blood vessels constrict in response; consequently, the peripheral circulation and thereby fingertip temperature decreases (Kiyatkin, 2021). Sympathetic tone decreases in response to stress reduction; consequently, the circulation in the skin increases, which will result in increased skin temperature (e.g., fingertip temperature). Likewise, heart rate and blood pressure decrease in response to a decrease in sympathetic tone (Rhoades & Bell, 2023, pp. 125–130). Vinkers et al. (2013) found that when healthy women and men carried out a Trier Social Stress Test, their fingertip temperature decreased significantly compared with the control treatment. Fingertip temperature exhibited the largest change of temperature in comparison with other areas of the body. This effect difference is because the level of vasoconstriction is the highest in peripheral parts of the body under basal conditions. Based on this information, it can be anticipated that if a dog and her handler have a stress-reducing effect on residents in nursing homes, this should be reflected by an increase in fingertip temperature and a decrease in heart rate and blood pressure.

It is common to treat high blood pressure and increased levels of anxiety, often observed in older people, with pharmaceutical drugs. This kind of treatment is often helpful; it may, however, be linked to side effects such as dizziness (Tinetti et al., 2000), which increases the risk of falling and consequent physical injury. Given that interaction with a dog–handler team may reduce blood pressure (Handlin et al., 2018) and anxiety in older people (Hoffmann et al., 2009; Kanamori et al., 2001), such interaction could be used as a non-pharmaceutical treatment for the residents. If such treatments are going to be introduced in a clinical setting, it is important to describe in greater detail which aspects of the interaction between the dog–handler team and the residents contribute the most to the positive effects on the residents.

In the present study, we present a subgroup of data from a large project in which multiple variables were studied in older people as a response to the interaction with a dog–handler team (Handlin et al., 2018; Nilsson et al., 2020). The aims of this study were threefold. Firstly, we wanted to record the profile of interactive behaviors taking place between residents at a nursing home and a therapy dog and her handler during visits by the dog–handler team to the nursing homes. Secondly, we wanted to analyze how the dog–handler visits changed the residents' fingertip temperature, heart rate, and blood pressure during the 60-min visit. Thirdly, we wanted to investigate possible relationships between the behavioral and physiological recordings obtained during the visits by the dog–handler team.

To the best of our knowledge, no previous studies have investigated if different aspects of observed interactive behaviors between a dog–handler team and the residents in a nursing home influence physiological variables in the residents.

Methods

Ethics Approval

The local ethics committee in Gothenburg, Sweden (ref. no. 669-10) approved the experimental procedure for the residents. The animal ethics committee in Uppsala, Sweden (ref. no. 283/10) approved the experimental procedure for the dog, and the Swedish Board of Agriculture (ref. no. D31-12610/10) approved the use of a privately owned therapy dog. Before the experiment started, the participants, as well as their relatives, were informed about the study and were given the opportunity to ask questions. They were also informed that they could end their participation in the study at any time without their decision affecting the care they received. The participant or relative (in case the participant was unable to write) signed a written consent for participation in the study.

Setting and Participants

A therapy dog, the dog handler, and two researchers visited residents at three different nursing homes located in the county of Skaraborg in the southwestern part of Sweden. Fifteen older people, five from each nursing home, were recruited into the study. The residents fulfilled the following criteria: they were Swedish-speaking and able to participate in a simple conversation, understand information and instructions, and make their own decisions. The included residents had no diagnosis of dementia or diabetes and no previous experience with therapy dogs. Some of the residents received pharmacological treatments for anxiety, pain, sleeping problems, and/or high blood pressure. They all used a walker or a wheelchair when moving.

For different reasons, data from only 12 of the 15 residents could be used for the analysis of behavioral interactions: 10 women (mean age = 90 years: range: 82–100 years) and two men (both were 80 years old). During the study, two female residents were unable to participate because of intermittent illness, and no data could be used from them. One female resident was excluded from the data analysis because she only had one recording. Another female resident was involved in the behavioral interactions but left the room before the physiological sampling at 60 min could be carried out. Therefore, data from the behavioral interactions were used for analysis, but no physiological data. Some of the other residents had problems sitting still and wanted to leave the living room before the 60 min had ended. Some did, which led to some missing data, but their remaining data could still be used.

The visits took place in the day room of the nursing homes, where the residents sat in suitable chairs or their wheelchairs next to each other in a semi-circle. In the day room, there were also chairs for the researchers and the dog handler. For the therapy dog, there were some toys and a water bowl. She also had an area on the floor between the dog handler and the residents where she could relax if she wanted to or if the dog handler told her to do so.

Therapy Dog

The therapy dog was a privately owned 2-year-old female Labradoodle, and the dog handler was a middle-aged woman. Both the dog and the dog handler had been trained for one year at the Swedish Care Dog School ("Vårdhundskolan") in Uppsala, Sweden and were trained to work with residents at nursing homes. The same therapy dog and dog handler performed all visits at the three nursing homes.

Study Design

In the present study, the therapy dog and her handler visited the nursing homes for four weeks. Each nursing home received two visits each week, one in the morning and one in the afternoon. During each visit, measurements were made of fingertip temperature, heart rate, and systolic and diastolic blood pressure at 0 min (the start), before the therapy dog and her handler entered the day room, after 20 min, and after 60 min. Some of the physiological data are described in detail in previous papers (see Handlin et al., 2018; Nilsson et al., 2020). The same researchers collected all physiological data. The collected data were grouped into two-week periods consisting of weeks 3–4 and weeks 5–6. Weeks 1–2 and 7–8 were before and after the dog visits and have been reported elsewhere (Handlin et al., 2018; Nilsson et al., 2020).

During the time between the measurements, the researchers were sitting in their chairs without interacting with the residents. The researchers answered questions from the residents but did not initiate a conversation with them.

Interaction Between Dog, Dog Handler, and Residents

At the beginning of each visit, the dog greeted each resident one after another by placing her head in their lap or by letting them stroke her. Then all participants interacted with the dog in different ways depending on their capabilities and the dog handler's instructions. For example, the residents talked to the dog or were engaged in physical activity with the dog, such as stroking her, playing with her, or giving her dog biscuits.

If physical problems hindered the resident from reaching and touching the dog, she was placed on a chair close to the resident, making it possible for there to be physical contact between them. After some time of interacting, the dog and the handler went to the next resident, making it possible for them to interact with the dog.

Physiological Measures

The participants' fingertip temperature was measured using a digital thermometer (Digital Thermometer, Esska.de GmbH, Hamburg, Germany). Blood pressure and heart rate were measured using an automatic blood pressure and heart rate gauge (Type 6050 3 V/2W Braun, Braun AG Kronberg, Germany), with an accuracy reading of ± 3 mmHg (cuff pressure) and ± 5% (pulse rate).

Behavioral Observations

All visits were videotaped with two portable video cameras (SONY, HDR-CX13C HD AVCHD, wide-angle 29.8 mm, 42 × extended zoom, 3.3 megapixels) placed on tripods covering different angles. The residents' interactive behaviors with the dog and the dog handler (Table 1) were analyzed from the tapes and coded using the program Mangold Interact GmvH, Germany. The coding was made so that only one behavior at a time could be recorded. One observer who was never present at the nursing homes during the visits by the dog–handler team analyzed the video recordings.

The behavior of the dog was recorded separately. The following behaviors and their definitions were used: active contact (dog has physical contact with the resident), inactive contact (dog stands or lies beside the resident, no active work), plays (dog plays and interacts with the resident and/or the handler with different toys), rests (dog rests on the floor, no command from the handler), and other (dog drinks water or moves to another resident).

Table 1. Ethogram describing the different interactive behaviors between the residents and the dog and its handler during the 60 min of interaction as observed from the video films.

Labeling of behavior	Definition of interactive behavior
Resident in physical contact with dog	The resident is in physical contact with the dog; for example, the dog has its head on the resident´s lap, arm, or hand
Resident close to dog	The dog has moved towards the resident and is standing close but is not in physical contact with the resident
Resident playing with dog	The resident plays with the dog, by throwing a ball, giving her a toy, or offering her biscuits
Resident looking at dog	The resident has his or her face turned towards the dog, looking at the dog
Resident verbal contact	The resident talks to the handler or is indirectly involved in a conversation with the handler or another resident
Handler in physical contact with resident	The handler is in physical contact with the resident; for example, holding her hand on the resident´s shoulder or arm
Handler close to resident	The handler is close to or in front of the resident (maximum one meter away) but not in physical contact to the resident

Notes: Both the labeling and the definition of the behaviors are given. Recordings were done on durations (s) of all behaviors.

Statistical Analysis

The data analyses were carried out using the program SAS (Statistical Analysis System Inc. Cary, USA, version 9.4). The eight behavioral interactions between the 12 residents and the therapy dog and her handler were first summarized into a mean value per resident at weeks

3–4 and weeks 5–6. Thereafter, means and standard errors were calculated for each behavioral interaction. To test if there were any significant differences between weeks 3–4 and 5–6, a Wilcoxon signed-rank test was used on the mean values per resident and weeks.

Mean values for fingertip temperature, heart rate, and systolic and diastolic blood pressure for each resident were calculated separately from data collected at 0 and 60 min (4 data collections per week). Thereafter, total mean values with standard errors were calculated for each two-week period (weeks 3–4 and 5–6). To test if there were any significant differences between sampling times, 0 and 60 min, a paired *t*-test was used (for one person, there were no data at 60 min, hence only 11 people were used in this analysis). As in a previous publication from this project (Handlin et al., 2018), the residents were also grouped into those with an initial systolic blood pressure ≥ 130 mmHg (range 130–154 mmHg, mean = 139 mmHg, $n = 4$) and those with an initial systolic blood pressure < 130 mm Hg (range 107–127 mmHg; mean = 117 mmHg, $n = 7$). The level of significance was set at $p < 0.05$.

A delta value was calculated for each physiological variable and for weeks 3–4 and weeks 5–6 by subtracting the value obtained at 0 min from that obtained at 60 min (positive delta values indicate that the variable increased from 0 to 60 min, whereas negative values indicate that the variable decreased from 0 to 60 min). The normality of the residual term was checked by plots. For each of the physiological variables, a mixed linear model (proc mixed) was used to test if there were any significant effects on the delta value (60–0 min) from the interactive behaviors. The explanatory variables for both weeks (3–4 or 5–6) and the blood pressure group (≥130 mmHg or < 130 mmHg) were included in the model as fixed factors, and the durations of behavioral interactions were included as covariates with their interactions. The nursing homes and the individual visits were included as random factors in the model. As the same residents were observed during different visits, an autoregressive error term, AR(1), was included to account for the dependence of these observations. The model was step-wise reduced by taking away the parameter that had the highest *p*-value and therefore most far away from being significant. The AIC (smaller is better) was used to decide when the best model had been reached. The effect size was calculated by adding differences of Least Square Means (LSM) to the proc mixed model, where the Estimate shows how large a difference there is between the LSM estimates for the two groups (i.e., weeks or blood pressure group). This calculation provides an estimate of the practical significance of the data independently of the sample size, where close to zero indicates low practical difference and higher values indicate a practical difference.

The associations that were significant ($p < 0.05$) are shown as scatter plots (created in Excel) with the linear trend line (y) and the R^2. The closer to 1 the R^2, the stronger the association.

Results

Interactive Behaviors Between the Residents, the Dog, and the Dog Handler

Seven types of interactive behaviors between the residents and the dog and her handler were identified and recorded. The most frequently recorded interactive behaviors between the residents and the dog were looking, physical contact, and playing (Table 2). The residents also talked to the handler and other residents and had physical contact with the handler. There were significantly more physical interactions with the dog during weeks 3–4 than during weeks 5–6 (Table 2).

Table 2. Mean duration (s/h) of the different interactive behaviors recorded between the resident and the therapy dog and its handler during weeks 3–4 and 5–6.

Interactive behavior	Weeks 3–4 Mean (*SE*)	Weeks 5–6 Mean (*SE*)	Differences *S*-value (*p*-value)
Handler close to resident	822.3 (61.99)	763.8 (98.60)	−13 (0.34)
Resident looking at dog	799.3 (119.29)	697.3 (132.80)	−11 (0.42)
Resident verbal contact	559.0 (79.95)	511.2 (66.14)	−13 (0.34)
Resident close to dog	510.9 (54.00)	514.0 (46.04)	1 (0.97)
Resident in physical contact with dog	183.3 (30.49)	108.6 (21.70)	**−39 (0.0005)**
Resident playing with dog	122.5 (43.42)	125.8 (47.36)	1.5 (0.92)
Handler in physical contact with resident	15.4 (7.13)	21.2 (10.41)	6 (0.46)

Note: Significant differences are presented in bold ($n = 12$).

Physiological Changes Recorded During the Intervention

The mean fingertip temperature, heart rate, and systolic and diastolic blood pressure of the residents before the dog–handler team entered the room (0 min), and directly after they left the room (60 min), as well as the difference between the values (delta value 60–0 min), are shown in Table 3. When the mean values obtained before and after the 60–min dog visit were compared, no significant differences were found. However, clear changes were observed during the treatment period in individual residents, but the direction of these varied.

Table 3. Mean (*SE*) fingertip temperature (Temp), heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) at 0 and 60 min and the difference (Δ) between them for experimental weeks 3–4 and 5–6.

Weeks	Time (min)	Temp (°C)[a]	HR (beats/min)[b]	SBP (mmHg)[b]	DBP (mmHg)
3–4	0 min	27.30 (0.56)	70.53 (3.91)	129.74 (3.82)	68.15 (3.14)
	60 min	28.68 (0.81)	69.15 (3.18)	128.36 (4.76)	66.69 (2.89)
	t (*p*-value)	1.89 (0.09)	−0.58 (0.58)	0.00 (1.00)	−0.96 (0.36)
	Δ0–60 min	1.44 (0.74)	−0.62 (1.93)	−4.35 (5.37)	−6.29 (6.93)
5–6	0 min	27.86 (0.54)	70.37 (3.12)	125.17 (4.02)	70.68 (2.88)
	60 min	28.23 (0.63)	68.48 (2.63)	127.26 (3.68)	68.20 (2.06)
	t (*p*-value)	0.36 (0.72)	−0.54 (0.60)	0.64 (0.54)	−1.02 (0.33)
	Δ0–60 min	0.007 (0.85)	−1.92 (1.90)	0.73 (3.24)	−3.79 (2.31)

Note: The paired *t*-test was used to compare differences between 0 and 60 min ($n = 11$).
[a]Data on 0 and 60 min for temperature have previously been published by Nilsson et al. (2020).
[b]Data on 0 min for HR and SBP have previously been published by Handlin et al. (2018).

In residents with an initial systolic blood pressure ≥ 130 mmHg, heart rate decreased significantly between 0 and 60 min during weeks 5–6 (Table 4). In addition, fingertip temperature tended to increase between 0 and 60 min during weeks 3–4 in residents with an initial systolic blood pressure ≥ 130 mmHg (Table 4).

Table 4. Mean (*SE*) fingertip temperature (Temp), heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) at 0 and 60 min and the differences (Δ) between them for experimental weeks 3–4 and weeks 5–6 for residents with a systolic blood pressure ≥ 130 mmHg ($n = 4$) and for those with a blood pressure < 130 mmHg ($n = 7$).

Blood pressure (mm Hg)	Weeks	Time (min)	Temp (°C)	HR (beats/min) [a]	SBP (mmHg)[a]	DBP (mmHg)
≥130	3–4	0 min	26.49 (0.93)	73 (6.47)	142.93 (1.69)	65.93 (6.36)
		60 min	29.65 (1.94)[b]	72.58 (1.69)	138.58 (1.91)	74.98 (0.82)
		Δ0–60 min	3.07 (1.62)	−0.62 (2.79)	−8.0 (1.68)	0.21 (1.99)
	5–6	0 min	28.38 (1.02)	72.13 (4.66)	137.54 (2.88)	76.94 (5.35)
		60 min	28.13 (1.35)	64.73 (3.09)[c]	134.83 (2.47)	69.96 (1.21)
		Δ0–60 min	−0.96 (2.29)	−4.87 (1.66)	−4.37 (7.15)	−9.62 (4.53)
<130	3–4	0 min	27.88 (0.66)	68.76 (5.19)	120.32 (2.99)	69.74 (3.29)
		60 min	28.13 (0.7)	67.19 (2.79)	122.51 (6.54)	62.18 (3.52)
		Δ0–60 min	0.51 (0.54)	−0.62 (2.75)	−2.26 (8.52)	−10.01 (10.88)
	5–6	0 min	27.48 (0.61)	69.37 (4.35)	118.09 (4.14)	67.11 (2.79)
		60 min	28.30 (0.71)	71.15 (3.78)	122.93 (5.01)	67.19 (3.20)
		Δ0–60 min	0.56 (0.49)	−0.23 (2.72)	3.64 (3.0)	−0.45 (1.72)

Note: The *t*-test was used to compare differences between 0 and 60 min in Temp and HR for residents with blood pressure ≥ 130 mmHg.
[a]Data on 0 min for HR and SBP have previously been published by Handlin et al. (2018).
[b]Differences between 0 and 60 min ($t = 2.57$, $p = 0.08$).
[c]Differences between 0 and 60 min ($t = -4.42$, $p = 0.02$).

Associations Between Duration of Interactive Behaviors and Changes in Physiological Variables

As both the numerical change of the physiological parameters and the duration of time of the different interactive behaviors were known, it was possible to calculate the predicted changes induced by the various interactive behaviors on the physiological parameters. The delta values of fingertip temperature were tested with all behavioral interactions in the model from the beginning. Those behavioral interactions that did not show any tendency to be associated with the fingertip temperature were step-wise removed from the model until only the significant ones, or those that were closest to being significant, remained. Both weeks (3–4 and 5–6) and initial systolic blood pressure (≥ 130 mmHg and < 130 mmHg) were kept in the model as they made the model stronger. Interaction between weeks and behavioral interactions were included in the model but removed if they were not significant. The same statistical analysis was thereafter carried out for the delta value of the heart rate.

Delta Value of Fingertip Temperature and Interactive Behaviors

There was a significant positive association between the delta value of residents' fingertip temperature and the duration of physical contact between the handler and the residents ($F_{(1, 37)} = 7.01$, $p = 0.0118$). This means that the longer the duration of physical contact the handler had with the residents, the larger the increase in fingertip temperature (Figure 1A). There was no significant interaction between the duration of physical contact between the handler and the residents and weeks ($F_{(1, 37)} = 2.41$, $p = 0.1288$), demonstrating that a similar association was obtained during both periods.

Physical contact between the residents and the dog was not significant but tended to be associated with an increased fingertip temperature ($F_{(1, 37)} = 2.99$, $p = 0.0924$). This

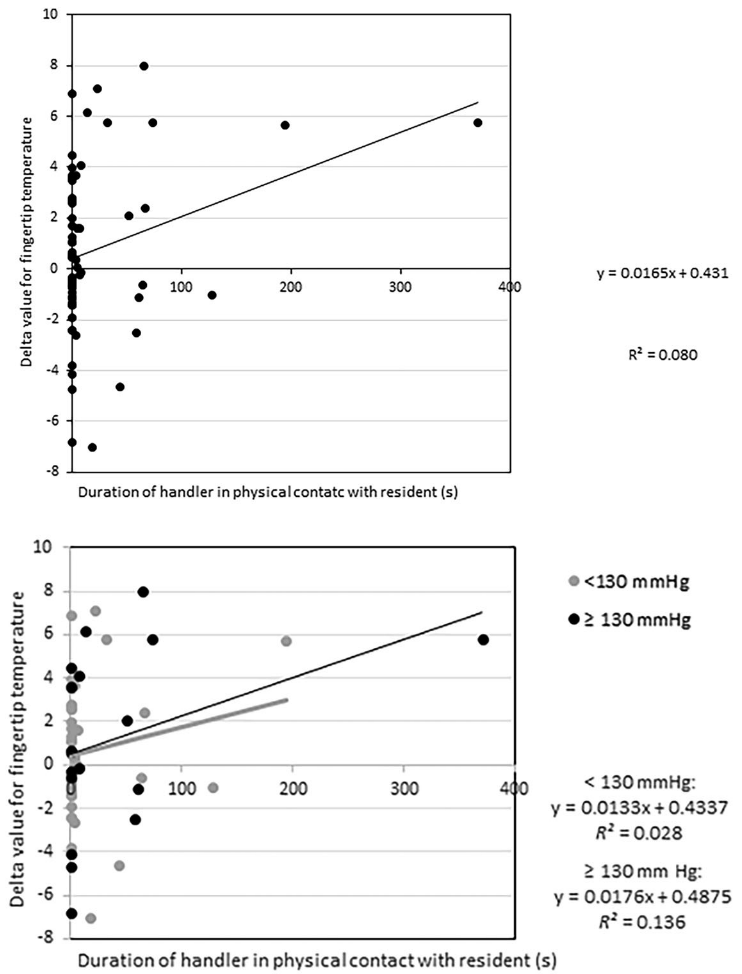

Figure 1. Association between delta values for fingertip temperature in residents and duration of time (s) that the handler had physical contact with the residents (A, $n = 11$ residents). Associations are also shown separately (B) for residents with blood pressure ≥ 130 mmHg ($n = 4$) and < 130 mmHg ($n = 7$) during the same visits. The therapy dog visited the nursing homes for 60 min twice/week for four weeks. The linear trend lines (y) and the R^2 values are shown.

means that the longer the time the residents had physical contact with the dog, the larger the increase in fingertip temperature tended to be (Figure 2A). There was also a significant interaction between the residents having physical contact with the dog and the experimental weeks ($F_{(1,\ 37)} = 4.65$, $p = 0.0377$).

The associations were slightly stronger for residents with an initial systolic blood pressure ≥ 130 mm Hg between the delta value for fingertip temperature and duration of handler in physical contact with the resident (Figure 1B) and duration of resident in physical contact with the dog (Figure 2B).

There were no significant differences between the delta values of fingertip temperature for residents with an initial systolic blood pressure ≥ 130 mm Hg or < 130 mmHg

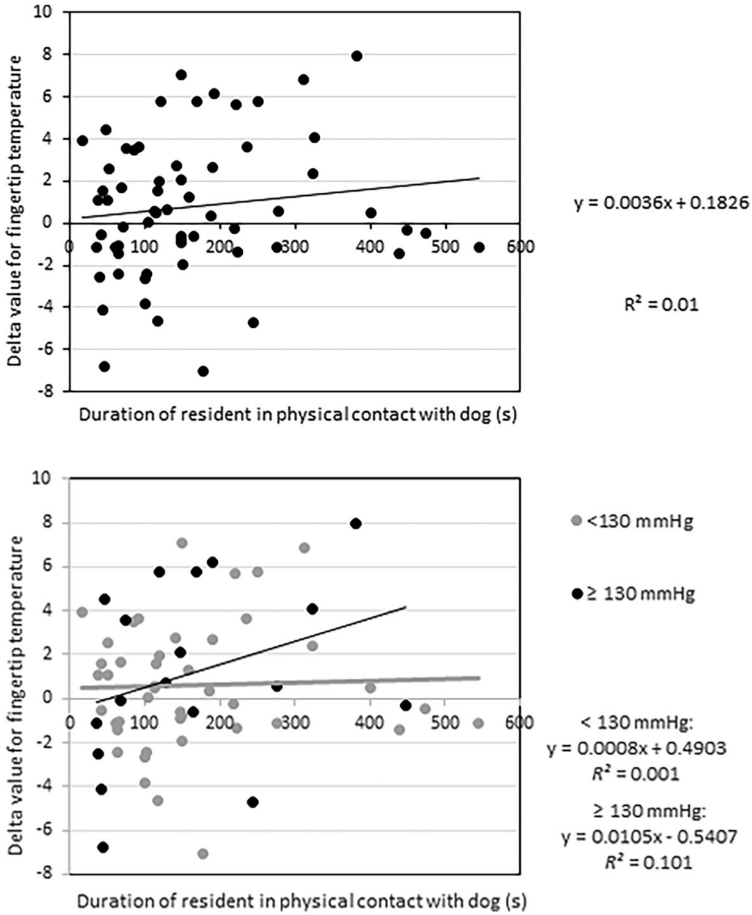

Figure 2. Association between delta values for fingertip temperature in residents and the duration of time (s) during which the residents were in physical contact with the therapy dog (A, $n = 11$ residents). Associations are also shown separately (B) for residents with blood pressure ≥ 130 mmHg ($n = 4$) and < 130 mmHg ($n = 7$) during the same visits. The therapy dog visited the nursing homes for 60 min twice/week for four weeks. The linear trend lines (y) and the R^2 values are shown.

($F_{(1, 37)} = 0.46$, $p = 0.5005$, effect size estimates = 0.6291). This means that the delta value for fingertip temperature was 0.6 units lower in residents with ≥ 130 mm Hg in initial systolic blood pressure compared with those with < 130 mm Hg. Further, there were no significant differences in the delta values for fingertip temperature between weeks 3–4 and 5–6 ($F_{(1, 37)} = 2.24$, $p = 0.1427$, effect size estimate = –0.0493). This means that the delta value for fingertip temperature was 0.1 units higher during weeks 3–4 than during weeks 5–6.

Delta Value of Heart Rate and Interactive Behaviors

There was a significant negative association between the delta value of heart rate and the duration of the residents having verbal contact with the handler or another resident ($F_{(1, 29)} = 6.80$, $p = 0.0143$). This means that the more the residents had verbal contact

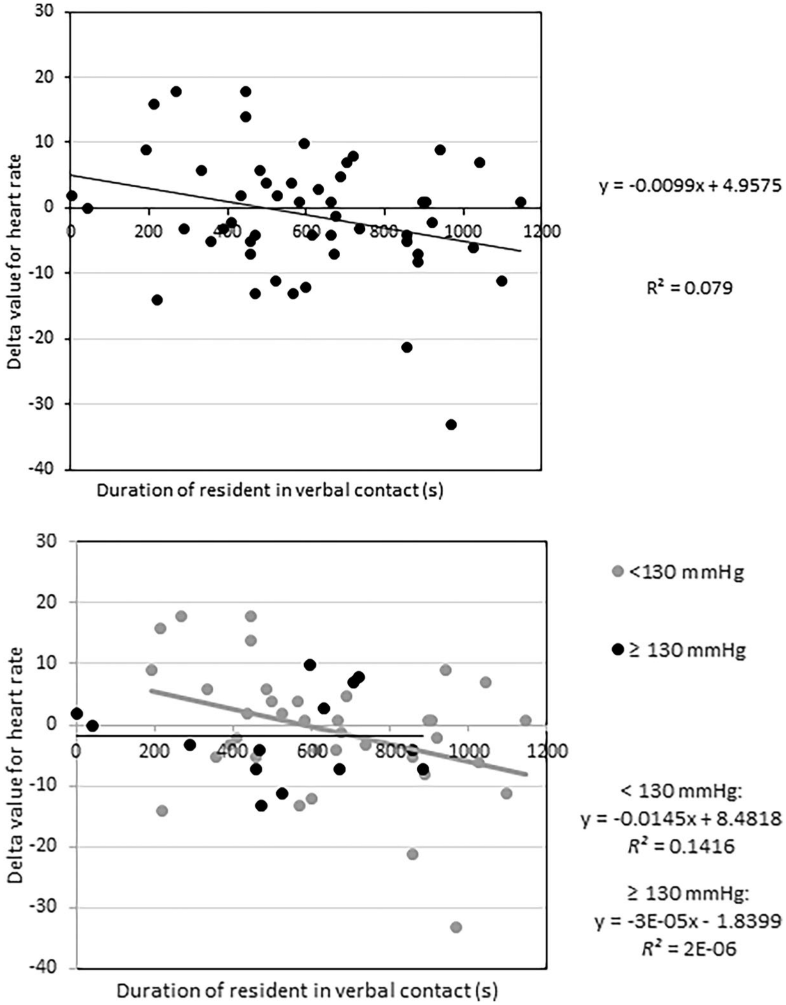

Figure 3. Association between delta values for heart rate in residents and duration of time (s) they had verbal contact with the handler or other residents (A, $n = 11$). Associations are also shown separately (B) for residents with blood pressure ≥ 130 mmHg ($n = 4$) and < 130 mmHg ($n = 7$) during the same visits. The therapy dog visited the nursing homes for 60 min twice/week for four weeks. The linear trend lines (y) and the R^2 values are shown.

with the dog handler, the larger the decrease in heart rate (Figure 3A). The decrease in heart rate was mainly found in the residents with blood pressure < 130 mmHg, whereas the residents with blood pressure ≥ 130 mmHg did not show any changes in heart rate (Figure 3B). There was also a tendency for a difference between the delta values for heart rate in residents with an initial systolic blood pressure ≥ 130 mm Hg compared with those with < 130 mmHg ($F_{(1, 29)} = 2.94$, $p = 0.0968$, effect size estimate = −4.3397). This means that the delta value for heart rate was 4.3 units higher in residents with ≥ 130 mm Hg in initial systolic blood pressure compared with those with < 130 mm Hg.

There were no significant differences in the delta values for heart rate between weeks 3–4 and 5–6 ($F_{(1,\ 29)} = 0.99$, $p = 0.3291$, effect size estimate = 2.4132). This means that the delta value for heart rate was 2.4 units higher during weeks 5–6 than in weeks 3–4. The duration of residents playing with the dog was also included in the model but was not significantly associated with the delta value of heart rate ($F_{(1,\ 29)} = 2.40$, $p = 0.1324$).

The Behavior of the Therapy Dog During the Intervention

Five behaviors were recorded in the dog: active contact, rests, plays, inactive contact, and other. During weeks 3–4, the dog appeared to have more active contact with the residents (i.e., having her head on the person's lap or arm) than during weeks 5–6 (Figure 4), but this could not be statistically tested due to the inclusion of only one dog in the study. In contrast, the dog appeared to spend more time resting on the floor during weeks 5–6 than during weeks 3–4 (Figure 4). In addition, the dog appeared to play slightly more with the residents during weeks 5–6 than during weeks 3–4. The duration of the dog being close to the residents, and other behaviors (i.e., the dog drinking water or moving between the residents) did not differ between weeks.

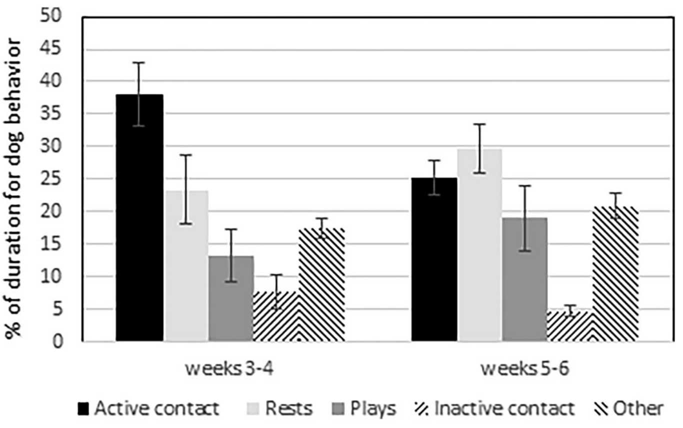

Figure 4. Mean percentage (± *SE*) of the duration of the therapy dog's behaviors when visiting the residents in the three nursing homes during weeks 3–4 and 5–6. The data represent the mean value of four visits per nursing home.

Discussion

A detailed analysis of the types of interactive behaviors that took place between residents at the homes for older people and a therapy dog and her handler during a 60-min period of interaction was performed. Changes in physiological markers of stress occurring in the residents during the interactions were also recorded. Finally, the existence of associations between the duration of the different types of interactions and the physiological changes were explored. Thus, the objective of this exploratory study was to discover which types of interaction between the residents and the dog–handler team have the greatest stress-relieving potential.

Behavioral Interactions With the Residents

The most common interactive behaviors (based on duration in s during the 60 min of interaction) were handler close to the resident, resident looking at the dog, resident in verbal contact with the handler or other residents, and resident close to the dog. The duration of these behaviors varied from more than 800 s (13 min) to around 500 s.

These data are roughly in agreement with previous studies conducted by Olsen et al. (2019) and Thodberg et al. (2016), showing that looking at the dog was a very common behavior performed by the older people. Verbal contact between the older person and other individuals has also been shown to be common in other studies (Olsen et al., 2019; Thodberg et al., 2016; Wesenberg et al., 2019). It should be noted that comparisons between different studies are not easy to make as the labeling of the interactive behaviors may differ, as does the duration of the intervention. In addition, the number of participating dogs and older people (Thodberg et al., 2016), as well as the number of nursing homes included (Olsen et al., 2019), vary between studies.

Physiological Changes Recorded During the Interventions

Some of the values of the physiological variables (i.e., fingertip temperature, heart rate, and systolic blood pressure) obtained in the residents before and after the interactions have been published in previous papers (Handlin et al., 2018; Nilsson et al., 2020), which together with the present paper derive from a larger, more comprehensive, study. Here we calculated the delta values from 0 to 60 min. This time span was chosen because the duration of the intervention was 60 min, and the behavioral interactions were analyzed for the whole 60-min intervention. In previous publications, 30 min in group sessions (Olsen et al., 2019) and 10 min in individual sessions (Thodberg et al., 2016) were used. These differences may explain why the delta values for the different physiological values differ between those obtained in the present and previous studies. In the earlier publications (Handlin et al., 2018; Nilsson et al., 2020), data from the 2-week control period without the dog-handler team before and after the four weeks of intervention with the dog–handler team are presented.

In the previous studies, we found a significant increase in fingertip temperature, and a decrease in heart rate and systolic blood pressure, between 0 and 20 min, an effect that in the case of blood pressure persisted over time (Handlin et al., 2018; Nilsson et al., 2020). In the present study, only a tendency for a decrease in fingertip temperature was recorded during the 60-min observation period.

An interesting finding was that the decrease in blood pressure was only found in individuals with a systolic blood pressure $\geq$ 130 mm Hg. This makes physiological sense, as there is no reason normal blood pressure to drop. Therefore, the effects observed during interactions between residents of nursing homes and a dog–handler team will in part be dependent on the prevailing stress levels of the residents. A previous study supports that the positive effects of a dog–handler team are only observed if the residents are stressed or do not have optimal health (Krause-Parello & Kolassa, 2016). The researchers found that heart rate and systolic blood pressure decreased more in residents when they, during 60 min, were visited by a volunteer dog–handler team than when the same residents were visited by a volunteer handler without a dog. Systolic blood pressure decreased more during the dog–handler team visits when the residents had poorer self-rated health, higher stress, and poorer coping (Krause-Parello & Kolassa, 2016). Walsh et al. (1995) found that heart rate decreased in residents with dementia during a dog-visiting program over 12 weeks compared with controls.

In this study, there were large individual differences and day-to-day variation within the same resident. Additionally, half of the sessions occurred during the morning and the other half during the afternoon; this could also have caused the different patterns of the physiological measurements.

Mechanisms Involved in the Physiological Changes During the Intervention

In the present study, we made an attempt to establish a relationship between the duration of the different interactive behaviors that were recorded and the physiological changes observed in the residents. Two interactive behaviors were associated with increased fingertip temperature: the resident being in physical contact with the dog and the dog handler being in physical contact with the resident. Resident verbal contact was associated with a decrease in heart rate. While these data must be regarded with great caution, they do indicate that physical contact as well as social contact contribute to decreased stress levels, most likely by increasing the activity in the oxytocinergic system and, in particular, those aspects that are linked to a decrease in sympathetic nerve activity.

Different types of interaction, tactile stimuli in particular, activate cutaneous sensory nerves, which change the balance of the autonomic nervous system from sympathetic to parasympathetic dominance. This shift is largely mediated by a release of oxytocin from the paraventricular nucleus (PVN) in the hypothalamus (Uvnäs-Moberg et al., 2019). An extensive network of oxytocinergic fibers originating in the PVN projects to a multitude of brain areas involved in stress regulation, where oxytocin decreases stress levels, including the activity in the sympathetic nervous system (Uvnäs-Moberg et al., 2019; Uvnäs-Moberg & Petersson, 2022). It can therefore be assumed that the interactions between the dog–handler team and the residents involved activation of the oxytocin system.

Oxytocin plays a role in social bonding between animals that are familiar with each other (reviewed by Rault et al., 2017), but it also seems to be related to social bonding between species. Oxytocin levels in humans and dogs increase during human–dog interactions (Handlin et al., 2011; Miller et al., 2009; Odendaal & Meintjes, 2003). Mitsui et al. (2011) found increases in urinary oxytocin after dogs had been stroked in the abdominal area for 15 min without social reinforcement such as vocal encouragement and eye contact. Also, when dogs gaze at their owners during social interaction, it increases the owner's urinary oxytocin (Nagasawa et al., 2009; 2015). The effect is reciprocal.

The data also imply that psychological effects contribute to the positive effect induced by the dog handler, as a strong correlation was observed between increased fingertip temperature and the very short-lasting period of physical contact between the dog handler and the resident (20 s). This phenomenon may be related to the psychological concept of social support; for example, a doula, a woman who provides women during birth with social support (Klaus & Kennell, 1997; Mosley & Lanning, 2020). Social support is linked to stress-buffering effects (Mosley & Lanning, 2020). The presence of a person who is experienced as supportive and safe will increase the activity in the oxytocinergic system emanating from the paraventricular nucleus. These oxytocinergic fibers project to areas involved in the regulation of fear, stress, and pain. When oxytocin is released from these nerves, the levels of fear, stress, and pain are decreased (Uvnäs-Moberg & Petersson, 2022).

Perhaps resting a hand on the resident's shoulder or arm for only a few seconds during a relaxing session in a group with other residents in the presence of the dog is very important for these residents. Just as interaction with the dog was expected to cause oxytocin release in the residents, the interaction with the handler may have caused a similar oxytocin release. Sensory stimulation such as touch, light pressure, and stroking are known to lead to oxytocin release (Uvnäs-Moberg et al., 2015; Uvnäs-Moberg & Petersson, 2022). The activation of thicker myelinated nerve fibers in response to light/moderate pressure with or without stroking is linked to anti-stress effects (Uvnäs-Moberg et al., 2019). Hendy (1987) found that close proximity to a visiting person was associated with a greater number of positive resident behaviors than a person visiting with a dog or the dog alone. Hendy (1987) even suggested that the human handler could have a confounding effect on research studying how visiting pets affects the resident. Savishinsky (1992) found that when volunteers on a regular basis visited residents in a geriatric clinic with companion animals, this re-created a home feeling for the residents, and the volunteers saw themselves as family and friends to the residents. Therefore, it may be difficult to separate the effect of the visiting dog from the effect of the dog handler, and it is suggested that they should be regarded as a dog–handler team, having a combined effect on the residents' fingertip temperature.

It is interesting that the residents' verbal contact with the handler and the other residents in the living room was associated with a decrease in heart rate. The presence of the dog and handler may have created a more relaxed environment for the residents, which stimulated them to start talking. They had something to talk about: that is, the dog, and she may have evoked memories of their own previous dogs, other animals, or family members (Swall et al., 2015). In a previous study, it was shown that when a human with a dog, a dog alone, or a human alone visited residents in a group at a nursing home, all residents had more smiles and were more alert (Hendy, 1987). Fick (1993) found that residents in a group therapy session had increased verbal social interactions when a dog was in the session than when it was not. Moreover, in another study on animal-assisted therapy (AAT) with both dogs and cats for residents in groups, it was found that they had a higher frequency of talking compared with other types of activities without animals (Bernstein et al., 2000). Visits to nursing homes by either a person and a dog, a person and a robot dog, or a person alone all stimulate socially interactive behavior such as conversation (Kramer et al., 2009).

Dog Behavior and Welfare

Reviews of dog welfare show that the behavioral and physiological responses of dogs involved in animal-assisted interventions differ between studies (Glenk, 2017; Glenk & Foltin, 2021). For example, the type of intervention and participants and length and frequency of sessions influence how demanding the work is for the dog (Glenk, 2017; Glenk & Foltin, 2021). In this study, the dog handler adapted the dog's activities according to her needs during the sessions, and she had a choice to walk away and rest. Thus, even if each session was 60-min long, the dog was not actively working the whole time, as shown in the results.

Methodological Strengths and Challenges

This study is unique as it attempted to analyze whether behavioral interactions between residents and a dog–handler team are associated with physiological changes in residents at a nursing home during a 60-min group intervention. Previous studies have used shorter intervention durations: 30 min (Olsen et al., 2019); 10 min (Thodberg et al., 2016). Having a 60-min intervention is good if you want to investigate what happens during a longer session. However, this led to some difficulties in the interpretation of the results as the physiological values in individual residents both increased and decreased during the 60 min. Some residents also had problems sitting still and wanted to leave the living room before the 60 min, which led to some missing data. Because of this, it is recommended to record behavior and physiology in parallel in order to help analyze and interpret the data. Interventions of different durations should be tested in order to investigate which duration of intervention is the most optimal for older people.

Most previous studies have used dog interventions in a group setting, as we did, but Thodberg et al. (2016) had an individual intervention. In a group setting, it is possible to investigate whether the interaction between the residents also changes when the therapy dog is present. In this study, the dog had to move between the residents, and there was a risk that some more active residents would be more in contact with the dog and her handler than those who were more sedentary. This may be one of the reasons for the large differences between individuals and the different intervention days. Colby and Sherman (2002) found that even though the majority of residents who interacted with a visiting dog at a nursing home received positive effects from the interactions, this did not apply to all residents. Winkler et al. (1989) found that a resident dog had positive effects on both residents at a nursing home and staff during a six-week intervention, but 22 weeks after the dog had left, the positive effects only remained in the staff. In this study, there was a 2-week recording period after the end of the dog–handler team visits; some positive effects on blood pressure appeared to remain.

It is a strength that the same dog–handler team visited the residents because this decreased the variation of the results within the study. It is also a strength that the same researchers performed the measurements throughout the entire study. In addition, as the researchers visited the nursing homes during the two weeks before the start of the actual study, this may have decreased the stress levels of the residents and made them more familiar with the data collection. A very important strength of the study is that measurements of the physiological parameters were done eight times, (twice a week for 4 weeks). This is an unusual number of observations and adds to the credibility of the data.

Conclusions

This exploratory study shows that the measured behavioral interactions with the longest durations were the handler close to the resident, the resident looking at the dog, the resident in verbal contact with the handler or other residents, and the resident close to the dog. The dog–handler team seemed to cause physiological changes in the residents. Fingertip temperature increased and heart rate decreased in response to the physical contact, probably reflecting a decrease in the activity of the sympathetic nervous system and a calming and relaxing effect induced by the interaction. The data presented here should be regarded with great caution, though, as the sample size was very small. Still, that some significant associations between interactive behaviors and anti-stress effects in the residents were observed is encouraging and raises the possibility of conducting new studies with more residents and more optimally designed observations, including definitions of the interactions to be studied. Such data may give information concerning the clinical importance of the future use of dogs and their handlers in the care of older people. The role of the dog and the handler, and perhaps the cooperation between them, might be of critical importance for the success of the intervention and should therefore be investigated in detail. Thus, even if this study might be regarded as an exploratory study owing to the small number of participants, it is unique.

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