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Using Psychological and Physiological Measures in Arts-Based Activities in a Community Sample of People with a Dementia and Their Caregivers: A Feasibility and Pilot Study

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Abstract

Introduction: Nearly all community-based dementia care studies employ either qualitative methods or use a combination of self-report questionnaires within mixed-methods research designs. Physiological measures, however, are rarely used in community-based studies with this population yet could provide valuable biological information for specific activities across the course of the dementias.

Method: The study employed a within-subjects design to assess the feasibility of obtaining physiological measures (salivary cortisol and Heart Rate Variability (HRV)) alongside subjective measures of wellbeing and stress using Visual Analogue Scales (VAS) during two community-based activities of choral singing and art viewing, respectively, for People With Dementia (PWD) in the early to middle stages of impairment and their caregivers.

Results: As anticipated, pre-post subjective wellbeing measures were relatively easy to complete by PWD and caregivers with no substantive difficulties observed or reported; significant increases in composite wellbeing, happiness and optimism were found. Continuous measurement of physiological data of HRV through a sensor-based device (Empatica® E4) was also found to be neither non-intrusive to participants nor disruptive to the interventions. Preliminary indications showed, for example, HRV significantly increased for PWD during choral singing, which may be associated with an increase in wellbeing. Measuring stress hormones through pre-post saliva samples, however, encountered several difficulties.

Conclusions: The findings provide support for the feasibility of using non-intrusive sensor-based physiological measures alongside subjective measures for this population. Subjective measures may also give more confidence in interpreting directionality of physiological measures. A full pilot study is warranted to further investigate interactions of physiological and psychological variables in choral singing and viewing art activities but it is uncertain whether measuring stress hormones through saliva collection is feasible for this population and raised doubts about their use in a large-scale trial. Holding particular promise is the use of sensor-based technology across different stages of dementia as well as across different activities.

Keywords: Dementias; Wellbeing; Stress; Biomarkers; Physiological measures; Choral singing; Art viewing

Introduction

The dementias are progressive neurodegenerative conditions that involve brain cell loss and affect cognitive, behavioural and emotional functioning. There are many types of dementia with the most commonly diagnosed being Alzheimer's Disease (AD), Vascular Dementia (VD), Fronto Temporal Dementia (FTD) and Dementia with Lewy Bodies (DLB). Dementia can lead to difficulties with memory, expressive language or comprehension, visuospatial skills, attention and orientation [1]. Some forms of dementia can affect social functioning (e.g. using inappropriate language or behaving in ways deemed inappropriate by others) and psychological functioning (e.g. anxiety, depression). People can develop difficulties with emotional regulation and capacity to deal with stress can be affected [2]. Over time, psychological difficulties and loss of independence can also lead to social withdrawal which can have a further impact on mood. Nonetheless, Kitwood T, et al. [3] highlighted that people can also experience positive emotions including humour, pleasure and affection when their psychological and social needs are being met.

Music in dementia care

One recommended non-pharmacological intervention for non-cognitive symptoms (e.g. agitation, anxiety, depression) is the "therapeutic use of music" [4] although a recent Cochrane review presented mixed results on its effectiveness for agitation and anxiety [5] whilst an earlier systematic review found music helpful in managing agitation within residential care environments [6]. Several studies have also found positive effects (particularly short term) of group singing on cognitive abilities [7,8], quality of life and communication [9] and irritability [8] in People With Dementia (PWD). Singing in a community-based group can also decrease social isolation, something particularly of concern for PWD [10] and be a viable social prescribing resource [11]. Others however, have found inconclusive results or no change in measures of anxiety and depression following group singing [12,13]. Also investigated has been the impact of singing on dementia caregivers [10]. Singing groups attended by both caregivers and PWD have been found to improve wellbeing, mood and social inclusiveness, provide a sense of belonging for both groups and have a positive impact on their relationship [14,15].

Visual arts in dementia care

The visual arts have been an increasing area for investigation in health care research [16] and specifically in dementia care and research over a number of years including the use of both qualitative and quantitative methods. Activities range from active to passive involvement and include participatory arts that involve people in making art (e.g. painting, ceramics, printmaking), handling art and heritage objects (e.g. museum object handling) using physical touch and in viewing art as part of a gallery tour or lecture and discussion [17]. Different outcomes measures have been used with visual arts including cognitive functioning [18,19] wellbeing [20,21] and quality of life [22].

Wellbeing in dementia

A consensus on the definition of wellbeing in the health sciences has not been reached, creating differences in its description and measurement between research studies. Wellbeing was originally based on theories of happiness and the ability to assimilate and accomplish one's goals [23]. The difficulties in conceptualising wellbeing were considered by Dodge R, et al. [24] who proposed a new definition, combining aspects from previous theories. They defined stable wellbeing as "when individuals have the psychological, social and physical resources they need to meet a particular psychological, social and/or physical challenge", depicting this as a "see-saw" with optimal wellbeing as the mid-point impacted upon by life challenges on one side and the resources to cope with these challenges on the other.

Measurement of stress

Cohen C, et al. [25] proposed a model of stress incorporating psychological, biological and environmental factors. The model describes how appraising an inability to manage environmental demands leads a person to perceive the situation as stressful, causing negative emotions. This is followed by physiological and behavioural responses which can increase the risk of physical illness and mental health difficulties. When a situation is perceived as stressful, the body enters an acute stress response, which includes the activation of the Hypothalamic-Pituitary-Adrenocortical (HPA) axis and the release of the steroid hormone cortisol [26]. One way that cortisol affects the body is to increase glucose production which prepares the body to react to stressful stimuli [27]. The definition of stress used in this study is a response characterized by physiological arousal and negative affect [28]. Although previous research has not commented on the prevalence of high stress levels in dementias, reported estimates of anxiety prevalence vary from 5 to 70 percent and anxiety is one of the most common mental health difficulties diagnosed in early stage dementia [13].

Subjective measures (e.g. self-report questionnaires and interviews) are the most common methods of assessing stress. One way to measure stress objectively is through using biomarkers (e.g. cortisol levels) [29,30]. Cortisol levels have been used to examine the effects of music on stress in healthy populations and reductions have been found following low stress singing (defined as group singing but not to an audience), concert attendance and group drumming interventions [31-33]; these same studies have also examined links between other hormones and stress levels including cortisone, testosterone, progesterone and Dehydroepiandrosterone (DHEA). Like cortisol, cortisone is a glucocorticoid, a hormone released from the HPA axis during the stress response. Testosterone and progesterone are gonadocorticoids (sex steroid hormones) affected by the body's stress response and DHEA is a steroid hormone involved in the body's immune response [33].

It is worth noting that salivary cortisol levels across the lifespan are not consistent and in older adults it has been associated with increased daily secretion, attenuated wake-evening slopes, and more pronounced cortisol awakening responses [34]. In a ten-year longitudinal study with older people, Herriot H, et al. [35] demonstrated that like inter-individual differences in cortisol secretion, "intra-individual cortisol variability across days may also reflect individual differences that foreshadow or contribute to health-relevant inflammatory processes." Kovach CR, et al. [36] looked at cortisol variation in a dementia population and identified three different slope patterns (negative (55%), flat (30%) or increased (7%)) across 111 participants. They found no statistically significant relationships between cortisol measurements, cognition and illness burden lending support to the "robustness of the diurnal pattern in advanced dementia."

A recent paper has recommended future research to investigate the effects of music on biomarkers in populations with different health conditions [37]. Using physiological measures of stress may be particularly relevant in research studies with people with cognitive impairment, who may not be able to accurately remember or communicate their levels of stress, including those with advanced dementia.

Heart Rate (HR) is another method of measuring the body's physiological response; it is controlled by the Autonomic Nervous System (ANS), which consists of two parts: the Sympathetic Nervous System (SNS) responsible for increasing HR, and the Parasympathetic Nervous System (PNS), responsible for rest and decreasing HR [38]. HR can be analysed crudely in mean changes in the number of beats per minute or by analysing Heart Rate Variability (HRV), the variation in the time interval between heartbeats [39]. These measurements can be difficult to interpret as they can be affected by numerous factors including anxiety, excitement and exercise [40]. However, evidence suggests HR is reliably influenced by stress [41], and different music tempi, with high tempo music increasing HR and low tempo reducing HR [42,43]. Healthy HRV indicates the body's ability to respond to different situations, and low HRV is associated with a range of health problems [44]. A relatively new area of research is assessing HR and HRV through using wearable sensors, however further work is needed to understand their reliability and validity.

The first known systematic review of physiological measures focusing on the arts and dementia found that of 13 identified studies,

all had been conducted with people with moderate to severe dementias in residential care or hospital settings using music therapy or music interventions [45]. Two recommendations for future research from this review suggested considering the type of intervention (art form) and specifying whether it is an active or passive activity. Although this classification approach has limitations in researching the variations of arts participation, it is one that can help to consider variables such as the amount and type of participant involvement and whether these have an impact on physiological, psychological and social outcomes.

Aims and Hypotheses

Reflecting on the current evidence concerning subjective wellbeing, stress and the impact of arts-based activities of those with a dementia and caregivers, the present study aimed to combine and expand upon these areas of research to

(1) Assess the feasibility of using multiple physiological and psychological measures in different community-based arts activities and settings among persons with dementia and caregiver dyads and

(2) Determine the effectiveness of different interventions (active and passive interventions) on wellbeing and stress among persons with dementia and caregivers by undertaking preliminary data analyses to inform future research.

Related to the first aim, we chose to compare two different art-based activities rather than a non-activity control group to better understand the viability of whether these measures could be successfully employed in different activities across different community settings.

For the purposes of the small-scale pilot study portion of the project we classified choral singing as the active intervention and an art viewing activity as the passive intervention. In preparation for future research, we were interested in exploring whether using different active and passive arts activities in early to middle stages of dementias would have an impact on objective stress and on subjective stress and wellbeing measures. This resulted in four hypotheses. In comparison with the passive intervention (art viewing), choral singing will significantly:

H1: Increase subjective wellbeing (CWS)

H2: Reduce subjective stress (Stress VAS)

H3: Reduce objective stress (salivary cortisol)

H4: Increase objective cardiovascular activity (HRV)

Method

A quasi-experimental design was employed in this naturalistic, feasibility study integrating data from physiological measures and self-report questionnaires.

Participants

Participants were recruited from an existing weekly singing group which had been running for approximately two months and all attendees were invited to participate (Table 1). Inclusion criteria: diagnosed with a mild to moderate dementia or the caregiver of an attending person, able to attend community-based activities, ability to give consent and not taking immunosuppressant medications, which can affect hormone levels. Ethical approval was obtained from a research ethics panel at Canterbury Christ Church University (V:\75\ethics\201516) and the study adhered to British Psychological Society guidance [46]. Participants' capacity to consent was carefully considered and where appropriate, a capacity assessment [47] was completed beforehand. All participants were deemed to have capacity to consent by two researchers. For the purposes of this feasibility study, we chose to recruit from an ongoing choral group to limit the impact of potential extraneous and confounding variables. Factors such as beginning a new group, uncertainty about what to expect, unfamiliarity with the facilitator and venue could have been confounding variables, which we controlled for as much as possible by sampling after the choral group was established. Because we were assessing the feasibility of interventions [48], measures and venues, we specifically waited until the choral group had been initially meeting for about two months. In a future larger scaled controlled study initial data collection would occur before the first meeting, at the first meeting and then at designated meetings over the course of the study.

Procedure

Two different activities were used in the present study, a choral singing activity conducted in a rehearsal room within a well-known concert hall and an art viewing activity facilitated in the community room of an equally well-known art gallery. Data were first collected from the singing activity and four weeks later from art viewing.

Choral singing:

Data collection: Upon arrival, Empatica-E4® wristbands were fitted to participants' dominant wrists, followed by collection of pre-measures of saliva, stress and wellbeing questionnaires. For saliva samples, participants placed swabs in their mouths and chewed for 60 seconds whilst holding onto the end to reduce the risk of swallowing the polymer roll. Once completed the swab was returned to the tube, immediately sealed and placed on ice. Samples were then frozen at -20°C for at least 3 weeks before analysis. Participants were asked not to eat or drink anything except water in the hour prior to giving the saliva sample and medications were documented; no participants indicated they were active tobacco smokers.

Activity description: The singing session then took place for the usual 60 minutes and was led by an experienced choral conductor and accompanied by a pianist. It began with a welcome song, initiated by the conductor as an indicator for group members to move to the two rows of seats as the session was starting, they also joined in with singing as they moved. Following this, participants engaged in physical (e.g. stretching) and vocal warm up exercises and sang three songs in both sitting and standing positions. The songs had previously been either partly or fully practiced in previous sessions. The choral group focused on vocal production and technique as well as exploring repertoire from sea shanties to opera (Table 2). At the end of the session, saliva samples and questionnaires were again completed and wristbands removed, followed by socialising and refreshments. The conductor was an experienced facilitator who had previously worked with older adult populations (Table 2).

Art viewing:

The passive intervention session consisted of art-viewing at a local gallery. Participants were previously invited to a two-hour exploratory session at the same venue two weeks before to familiarise themselves with the environment. In order to maintain experimental control as much as possible in community settings, we wanted to reduce the impact of a new venue on participants. Considering this is an older population of people with dementias we reasoned that having them come to the art gallery in advance of the intervention would familiarize them with the location of the venue, access routes and interior space. This appeared to be successful as participants voiced no trepidation about coming to the art gallery. Having some familiarity of the setting ahead of the passive intervention reduced potential worry, stress or confusion as confirmed by observations by researchers and reports from participants.

Table 1: Participant demographics.

Person with dementia					Caregiver					Both
Participant	Gender	Age	Ethnicity	Dementia diagnosis[b]	Participant[a]	Gender	Age	Ethnicity	Relationship to PWD	Sessions attended
102	F	<65	W British	AD	101	F	<65	W British	Professional caregiver	Both
103	M	65-75	W European	FTD	DNC					Singing only
104	M	65-75	W British	DLB	105	M	65-75	W British	Professional caregiver	Both
107	F	65-75	W European	AD	DNC					Both
110	F	>85	W European	AD	100	F	<65	W British	Daughter	Both
112	M	76-85	W British	AD	111	F	65-75	W British	Wife	Both
114	M	65-75	W British	Mixed dementia	113	F	76-85	W British	Wife	Both
115	M	76-85	W British	AD	106	F	<65	W British	Wife	Both
119	F	>85	W British	AD	DNC					Singing only
123	M	76-85	W British	FTD	DNC					Singing only
DNC					118	F	<65	W British	Sister (who did not participate)	Singing only
	Mean age (SD): 76.5 (8.78)					**Mean age (SD):** 60.86 (11.10)				
	Range: 62-91					**Range:** 45-79				

[a]DNC refers data not collected where PWD attended the group without a caregiver or caregivers participated in the study but the person they care or did not

[b]AD-Alzheimer's disease; FTD-Frontotemporal dementia; DLB-Dementia with Lewy bodies; Mixed dementia-Both AD and FTD

Table 2: Sample repertoire of songs sung by the choir.

Come and Sing (Nick Prater)
Bella Mama (Torres Strait islands)
Bei Männern (Mozart; from Magic Flute)
Rio Grande (Sea shanty)
Wiegenlied (Brahms)
Erie Canal (Thomas S Allen arr. John Owen Edwards)
Dona nobis pacem (Traditional canon)
Oh what a beautiful morning (Rodgers and Hammerstein)

Data collection: The same data collection procedures were employed as stated above in the choral singing session.

Activity description: The session was led by an experienced gallery educator who displayed PowerPoint slides of paintings, described the paintings' history and engaged the group by asking questions. There were also three opportunities to stretch and move around, which mirrored the physical activity in the singing session. Fourteen paintings from the 17th and 18th centuries were shown in pairs and people were asked to interpret and identify links between paintings. Visualisation techniques were also used (e.g. imagine you are in this scene, what can you hear/see/smell?). In an attempt to maintain experimental similarities, the session lasted 60 minutes at the same time and day of the week as the singing session. Like the conductor in the singing session, the art viewing facilitator was an experienced gallery guide who had previously worked with older people. Art-viewing as a passive intervention was chosen to account for group effects, facilitator expertise and similar levels of movement, which were determined for each activity beforehand to closely, align with those in the choral singing group.

Measures

Subjective measures: The Canterbury Wellbeing Scales (CWS) [20] are comprised of five visual analogue-style sub-scales (Happiness, Wellness, Interest, Confidence, Optimism) developed to measure subjective wellbeing in PWD and caregivers. Each scale is numbered from 0-100 with higher scores indicating a more positive response. A composite score of the sum of all scales is also calculated (0-500). The directions are read out loud and participants are asked to mark on a line numbered from 0 to 100 how they feel in the present moment as they complete the scales. The CWS have been used in previous studies involving PWD and caregivers [49,20] and reliability analyses found good internal consistency [20].

Alongside the CWS, participants also completed a visual analogue-style stress scale to indicate their subjective stress levels in that moment (stressed/not stressed, 0-100 with higher scores indicating less stress). Lesage, et al. [50] found support for the interconcept and construct validity of Visual Analogue Scales (VAS) for measuring stress and concluded that they are "at least as discriminating as a questionnaire" when comparing two groups. Others have found that PWD use VAS scales "in a similar way to the general population" [51]. VAS scales were chosen as they are valid for use in within-subjects designs, can assess change over short periods of time, are reliable, brief and easy to administer; important considerations when assessing PWD [23,52].

Saliva assays: Materials for saliva collection included the SalivaBio® Oral Swab, valid for measuring the hormones tested in this study [53]. Levels of five hormones (cortisol, cortisone, testosterone, progesterone and DHEA) were measured, all of which have previously been used as indicators of stress in music-based research with non-dementia populations [31,32] but have not yet been used in visual arts activities that the authors were aware.

Heart rate variability and wearable sensors: Wearable sensors were used to monitor continuous measurement of blood volume pulse (from which HRV can be derived). To explore the effects of group singing on HRV in this population, Empatica-4® [54] wristbands were placed on the dominant wrist of each participant as they entered the room and prior to the beginning of the session and removed following post-group measures. As part of the feasibility study we collected

but did not analyse additional measures from the Empatica E4®: Sympathetic Nervous System Arousal (EDA), Emotion-Based Activity (ACC) and Skin Temperature (ST).

Data analysis

In order to address the pilot project component of the study, sample size was pre-determined due to group membership therefore a G*Power sensitivity analysis was computed rather than a priori [55]. With an α score of 0.05, power of 0.80 and sample size of 20, a medium effect size for dz is 0.59 meaning that this sample size would only detect significant differences if the effect size is ≥ 59. Analysis was completed using SPSS version 24. Initial data screening indicated that the requirements of parametric data were not consistently met, therefore Wilcoxon signed-rank tests were used (Table 3). Pearson's r effect sizes were reported for all analyses [56]. Pre- and post-session scores for the CWS, stress scale and stress hormone levels for PWD and caregivers were compared for both the singing and art viewing sessions. Change scores were also calculated by subtracting pre-scores from post- scores and were compared between sessions using Wilcoxon tests; the stress scale was inversely scored, where a higher score indicated less stress. Bonferroni-corrected significance levels were used for the CWS (a=0.05/6=0.008) and HRV (a=0.05/3=0.015) to reduce the risk of Type 1 errors due to the use of multiple statistical tests [57]. Mean HRV values were determined for three time periods (baseline, during and post) from audio recordings of each session. The 'during' period comprised all the time between the leader of the activity commencing and finishing the formal group activity. For the singing session, the baseline and post intervention periods were 2 minutes 33 seconds and for the art viewing session, 3 minutes baseline and post art viewing activity (the maximum period between fitting the Empatica-4® devices and commencing the activity for which data was available for all participants). Mean HRV values were calculated for each individual for the entirety of each period for each session (Table 3).

Quality assurance

Subjective measures were scored blind in that the person who tallied responses did not know if they came from the singing or art viewing group. Researchers and staff assisted in data collection, reducing the possibility of group members assisting one another and potentially biasing results. Saliva assays can be affected by a number of factors including eating or drinking within one hour of giving the sample and some medications [53]. Participants were therefore asked not to eat or drink anything except water in the hour prior to giving the saliva sample and medications were documented. All data were stored in accordance with the Data Protection Act 1998 [58].

Results

Aim 1

Twenty people were approached and all but three consented to participate; two provided no reason and one responded "research is not for me". Seventeen (10 PWD/7 caregivers) completed measures at the singing session and 13 (7 PWD/6 caregivers) at the art making session. All participants who attended both sessions freely allowed the Empatica-4® wristbands to be attached completed the subjective measures quickly and without apparent difficulty and required only minimal assistance. The wristbands are similar to a large wristwatch in size and shape and although are required to fit snugly, there were no reports of discomfort. We were able to successfully collect date from all participants.

Only one participant, a person with dementia, without offering a reason refused to give a saliva sample post-art viewing group session, which is a similar percentage to previous reports with a dementia population [36]; we also had decided beforehand not to approach anyone a second time if they declined any measure. Overall, people appeared pleased to have participated in the research and as one man jokingly informed us, "Who likes to fill out questionnaires! But it wasn't all that bad. I hope we were able to help out." Any data collection method has the possibility of interfering with the impact of an activity and in this study, we were aware that the enjoyment of singing and viewing visual art could be compromised by overly burdensome or intrusive measures. As researchers, we had some concern that requesting saliva samples may have produced embarrassment and be experienced as something unseemly, but this did not at all appear to have been the case. Relating to our first aim, this leads us to conclude these measures are viable to be used in different arts-based activities, with the caveats stated below.

There were difficulties analysing data from this particular method of saliva collection (chewing a swab to collect a saliva sample) resulting in too small a sample size for analysis at the art viewing sessions. The reasons for less saliva being collected are unclear as the time of day, procedures and personnel present were the same. It may have been affected by the high external temperature that day (30°C/86°F) and the possibility that people may have been experiencing some level of dehydration. The high temperature may have also been the reason why four fewer people attended this session even though they all had been to the venue two weeks before to familiarise themselves with it.

Aim 2

The second aim of this project was to undertake a small-scale pilot study using two active control conditions in order to undertake preliminary data analysis. The initial analysis involved data being cleaned to remove one outlier (caregiver) from the cortisol data, which was outside the limits of laboratory detection. This is standard practice with biological samples. Examination of histograms and significant results on Kolmogorov-Smirnov tests (Table 4) showed that some variables were not normally distributed; therefore, non-parametric equivalents were used for all analyses. These need to be interpreted with caution due to small sample sizes.

Subjective stress scale

Stress decreased for both PWD and caregivers after the singing session and for caregivers after the art viewing session ($p>0.05$). PWD reported a significant increase in stress following the art viewing session with a large effect size ($p=0.027$, $r=-0.59$). When comparing both sessions there were no significant differences ($p>0.05$).

Canterbury Wellbeing Scales

Full details of the six CWS analyses can be seen in table 3. The Bonferroni-corrected significance level was 0.008. Following the singing session PWD showed significant increases on the composite, happiness and optimism scales with large effect sizes ($p<0.008$, $r=-0.60$ to -0.63). CWS scores were mixed in the art viewing session and there were no significant differences on Wilcoxon signed-rank tests ($p>0.008$). When comparing change in CWS scores between sessions, although greater increases in overall wellbeing (composite score), happiness, wellness and optimism occurred following the singing for both PWD and caregivers, none of the analyses were significant ($p>0.008$).

Saliva assays

The sample size was further decreased when analysing the saliva samples. This was due to an insufficient amount of saliva in some

Table 3: Results from Wilcoxon signed-rank analyses pre- and post- data for subjective stress; wellbeing and stress hormone levels.

	Session					
Measure	**Singing session PWD**	**Singing session caregiver**	**Art viewing session PWD**	**Art viewing session caregiver**	**Comparison between singing and Art viewing PWD[a]**	**Comparison between singing and Art viewing care giver[a]**
Self-report questionnaires						
Stress	Pre 76.80 (17.97)	Pre 62.00 (36.77)	Pre 80.00 (26.34)	Pre 70.00 (22.05)	Singing -3.00 (24.70)	Singing 20.83 (31.32)
	Post 78.90 (26.95)	Post 80.86 (12.52)	Post 62.00 (30.68)	Post 75.67 (20.87)	Art viewing -18.00 (27.20)	Art viewing 5.67 (18.98)
	n=10; z=-0.56	n=7; z=-1.36	n=7; z=-2.21	n=6; z=-0.63	n=7; z=-1.35; p=0.176	n=6; z=-0.94; p=0.345
	p=0.575; r=-0.13	p=0.173; r=-0.36	p=0.027*; r=-0.59	p=0.528; r=-0.18	r=-0.36	r=-0.27
CWS* Composite**	Pre 333.60 (77.53)	Pre 343.14 (93.22)	Pre 368.33 (97.00)	Pre 360.17 (93.79)	Singing 53.33 (26.07)	Singing 82.00 (75.21)
	Post 412.80 (63.54)	Post 426.86 (41.69)	Post 387.83 (86.71)	Post 407.83 (60.60)	Art viewing 19.50 (41.20)	Art viewing 47.67 (64.96)
	n=10; z=-2.80	n=7; z=-2.20	n=6; z=-1.15	n=6; z=-1.58	n=6; z=-1.15; p=0.249	n=6; z=-0.41; p=0.686
	p=0.005**; r=-0.63	p=0.028; r=-0.59	p=.249; r=-0.33	p=0.115; r=-0.46	r=-0.33	r=-0.12
CWS 1-Happy	Pre 60.70 (23.83)	Pre 57.00 (29.26)	Pre 81.29 (22.54)	Pre 68.67 (24.67)	Singing 16.86 (14.32)	Singing 27.00 (18.62)
	Post 80.70 (23.82)	Post 83.00 (18.95)	Post 67.43 (24.51)	Post 73.50 (19.76)	Art viewing -13.86 (19.35)	Art viewing 4.83 (18.59)
	n=10; z=-2.70	n=7; z=-2.20	n=7; z=-1.36	n=6; z=-0.54	n=7; z=-1.86; p=.063	n=6; z=-1.99; p=0.046
	p=0.007**; r=-0.60	p=0.028; r=-0.59	p=0.175; r=-0.36	p=0.588; r=-0.16	r=-0.50	r=-0.57
CWS 2-Well	Pre 60.30 (31.60)	Pre 66.00 (29.12)	Pre 73.00 (29.83)	Pre 69.33 (22.30)	Singing 20.29 (31.79)	Singing 17.50 (21.70)
	Post 84.30 (16.68)	Post 83.57 (11.43)	Post 69.14 (27.96)	Post 74.50 (17.13)	Art viewing -3.86 (31.34)	Art viewing 5.17 (15.35)
	n=10; z=-2.10	n=7; z=-1.99	n=7; z=-0.31	n=6; z=-0.63	n=7; z=-1.18; p=.23	n=6; z=-0.84; p=0.400
	p=0.036; r=-0.47	p=0.046; r=-0.53	p=0.753; r=-0.08	p=0.528; r=-0.18	r=-0.32	r=-0.24
CWS 3-Interested	Pre 73.30 (21.77)	Pre 80.00 (16.93)	Pre 71.29 (22.47)	Pre 77.17 (14.84)	Singing 3.57 (28.34)	Singing 2.83 (20.06)
	Post 85.20 (12.77)	Post 85.57 (7.50)	Post 76.00 (28.38)	Post 88.67 (15.83)	Art viewing 4.71 (18.21)	Art viewing 11.50 (19.08)
	n=10; z=-1.07	n=7; z=-0.67	n=7; z=-1.05	n=6; z=-1.47	n=7; z=-0.51; p=0.612	n=6; z=-0.94; p=0.345
	p=0.284; r=-0.24	p=0.500; r=-0.18	p=0.292; r=-0.28	p=0.141; r=-0.42	r=-0.14	r=-0.27
CWS 4-Confident	Pre 77.70 (17.03)	Pre 72.86 (24.27)	Pre 72.67 (22.69)	Pre 73.33 (24.38)	Singing -1.50 (20.10)	Singing 13.00 (21.11)
	Post 80.80 (15.34)	Post 86.43 (6.32)	Post 80.67 (17.34)	Post 87.17 (7.71)	Art viewing 8.00 (15.94)	Art viewing 13.83 (18.91)
	n=10; z=-0.87	n=7; z=-1.57	n=6; z=-1.08	n=6; z=-1.47	n=6; z=-0.94; p=0.345	n=6; z=-0.52; p=0.600
	p=0.386; r=-0.19	p=0.116; r=-0.42	p=0.279; r=-0.31	p=0.141; r=-0.42	r=-0.27	r=-0.15
CWS 5-Optimistic	Pre 61.60 (24.90)	Pre 67.29 (23.79)	Pre 67.86 (23.43)	Pre 71.67 (22.68)	Singing 17.14 (11.01)	Singing 21.67 (24.25)
	Post 81.80 (23.46)	Post 88.29 (4.27)	Post 72.29 (36.73)	Post 84.00 (12.62)	Art viewing 4.43 (23.12)	Art viewing 12.33 (12.19)
	n=10; z=-2.67	n=7; z=-2.20	n=7; z=-0.73	n=6; z=-2.02	n=7; z=-1.61; p=0.108	n=6; z=-0.32; p=0.752;
	p=0.008**; r=-0.60	p=0.028; r=-0.59	p=0.463; r=-0.20	p=0.043; r=-0.58	r=-0.43	r=-0.09
Physiological						
Cortisol	Pre 3.01 (2.00)	Pre 3.87 (2.17)	Pre 4.22 (1.67)	Pre 2.44 (1.05)	Singing -0.66 (.25)	Singing -2.13 (1.50)
	Post 2.60 (1.90)	Post 2.26 (1.02)	Post 3.26 (1.48)	Post 3.06 (1.78)	Art viewing 0.25 (2.56)	Art viewing 0.62 (1.96)
	n=6; z=-1.36	n=5; z=-1.48	n=3; z=-0.54	n=4; z=-0.37	n=2; z=-0.45; p=0.655	n=4; z=-1.83; p=0.068
	p=0.173; r=-0.39	p=0.138; r=-0.47	p=0.593; r=-0.22	p=0.715; r=-0.13	r=-0.23	r=-0.65
Cortisone	Pre 5.96 (2.21)	Pre 6.95 (1.71)	Pre 8.09 (3.29)	Pre 5.32 (1.12)	Singing 1.48 (2.96)	Singing -2.03 (0.32)
	Post 6.77 (4.37)	Post 5.28 (1.24)	Post 6.58 (1.47)	Post 5.33 (1.37)	Art viewing -1.84 (3.28)	Art viewing 0.02 (1.24)
	n=7; z=-0.51	n=5; z=-2.02	n=4; z=-1.10	n=4; z=0.00	n=3; z=-0.54; p=0.593	n=4; z=-1.83; p=0.068
	p=0.612; r=-0.14	p=0.043*; r=-0.64	p=0.273; r=-0.39	p=1.000; r=0.00	r=-0.22	r=-0.65
Testosterone	Pre 12.99 (13.14)	Pre 11.72 (11.85)	Pre 11.56 (11.74)	Pre 10.19 (10.06)	Singing -2.51 (3.98)	Singing 0.90
	Post 12.53 (13.18)	Post 11.64 (13.24)	Post 12.47 (12.38)	Post 9.73 (12.54)	Art viewing -1.49 (5.18)	Art viewing 2.40
	n=6; z=-0.11	n=2; z=-0.45	n=4; z=-0.73	n=3; z=0.00	n=3; z=-1.07; p=0.285	n=1
	p=0.917; r=-0.03	p=0.655; r=-0.23	p=.465; r=-0.26	p=1.000; r=.00	r=-0.44	

*p<0.05
**p<0.008 (Bonferroni corrected significance level)
*** CWS=Canterbury Wellbeing Scales
[a]These figures refer to change in mean scores

Table 4: Kolmogorov-Smirnov tests of Normality.

Session	Measure	Kolmogorov-Smirnov results		
		Statistic	df	Sig.
Singing session				
	Stress VAS	0.135	17	0.2
	CWS composite score	0.15	12	0.2
	CWS happiness	0.096	17	0.2
	CWS wellness	0.153	17	0.2
	CWS interest	0.203	17	0.06
	CWS confidence	0.149	17	0.2
	CWS optimism	0.102	17	0.2
	Cortisol	0.183	11	0.2
	Cortisone	0.228	12	0.085
	Testosterone	0.282	8	0.06
	HRV before-during	0.193	16	0.114
	HRV after-before	0.147	16	0.2
	HRV after-during	0.226	16	0.028*
Art viewing session				
	Stress VAS	0.256	13	0.020*
	CWS composite score	0.149	12	0.2
	CWS happiness	0.16	13	0.2
	CWS wellness	0.261	13	0.015*
	CWS interest	0.179	13	0.2
	CWS confidence	0.188	12	0.2
	CWS optimism	0.178	13	0.2
	Cortisol	0.208	7	0.2
	Cortisone	0.25	8	0.151
	Testosterone	0.19	7	0.2
	HRV before-during	0.176	12	0.2
	HRV after-before	0.194	12	0.2
	HRV after-during	0.301	12	0.004*

Note: *Significant results indicate data which significantly deviates from a normal distribution

vials. As a result, statistical analysis could not be completed on the progesterone and DHEA hormones. Wilcoxon signed-rank tests were performed on the remaining three hormones, cortisol, cortisone and testosterone; however, as sample sizes ranged from n=2-7 (Table 3) conclusions cannot be drawn from these very limited results. All caregivers showed a decrease in cortisone levels following the singing session, this difference was significant and had a large effect size (p=0.043, r=-0.64). When the two groups were combined, the decrease in cortisol levels for participants reached statistical significance, suggesting that a larger sample size in future studies may be able to detect meaningful change. Both PWD and caregiver cortisol and testosterone levels decreased non-significantly following the singing session.

In the art viewing session none of the analyses were significant nor were they when comparing between activities. It is worthwhile noting two non-significant results that would be useful to explore in a future study: For PWD, cortisol and testosterone levels showed a greater decrease following choral singing compared to art viewing (p>0.05) and for caregivers, cortisol and cortisone levels showed a greater decrease following the singing session compared to art viewing and, although the latter were not significant they were approaching significance and had large effect sizes (p=0.068, r=-0.65).

Heart rate variability

HRV analysis was based on 16 participants (9 PWD, 7 caregivers) at the singing session and 12 (6 PWD, 6 caregivers) at the art viewing session. Data analysis used Wilcoxon signed-rank tests to compare mean HRV scores for the time periods before-during, during-after, before-after each activity. The mean change in HRV between the time periods was also compared between the singing and Art viewing sessions using Wilcoxon signed-rank tests (Table 5, Figure 1).

When comparing HRV during the singing session to before and after, PWD had significantly more variability during the session compared to the other time periods. In art viewing, none of the analyses were significant (p> 0.015).When comparing HRV across the sessions none of the analyses were significant (p> 0.015).

Discussion

The primary aim of this study was to assess the feasibility of using both physiological and psychological measures to investigate the influence of two different art-based activities (choral singing and art viewing) on stress and wellbeing in PWD and caregivers. A secondary aim was to undertake a small-scale pilot study, in preparation for larger-scaled studies, to examine within-activity and between-activity comparisons for PWD and caregivers. We wanted to explore tentative areas of impact and possible trends to consider in a future community trial and to investigate the feasibility of active and passive arts activities. The study sought to build on previous research in dementia care by adding objective physiological measures [45] alongside subjective visual analogue scale measures of wellbeing [20] and stress [52].

The results support that sensor-based physiological data collection using the Empatica-4® is a viable approach to use for people in early to middle stages of dementias. Although we only chose to analyse one output (HRV) from this device for the present paper, we can confirm that other measures taken by the Empatica-4®, Sympathetic Nervous System Arousal, Emotion-Based Activity and Skin Temperature (ST) were also reliably recorded and hold promise to help researchers and clinicians better understand the relationship between subjective psychological reports and objective physiological measures. Wearable sensors used in combination with subjective measures can give confidence to interpretations of the directionality of HRV and other physiological measures such as EDA for example, where higher levels could indicate anxiety or excitement.

Pilot study

The pilot portion of the study developed four hypotheses to investigate in preparation for future larger-scaled projects. Regarding H1, CWS subscale scores for happiness and optimism and the composite score significantly increased for PWD following the singing session. However, following Bonferroni corrections none of the CWS scores for caregivers were significant, and none of the increases were significantly greater compared to art viewing, therefore H1 is only partially supported for PWD in the singing session. The increases in some CWS scores for PWD support findings from previous research into the wellbeing effects of singing [10].

Table 5: Wilcoxon signed-rank analyses of heart rate variability.

	Session Singing session PWD	Singing session caregiver	Art viewing session PWD	Art viewing session caregiver	Comparison between singing and Art viewing PWD[a]	Comparison between singing and Art viewing caregiver[a]
During *vs* before	During 192.53(166.18)	During 95.62 (66.35)	During 100.39 (136.15)	During 60.27 (64.84)	Singing 74.93 (76.21)	Singing 63.96 (51.64)
	Before 37.87 (53.84)	Before 12.27 (19.96)	Before 29.77 (27.57)	Before 58.22 (92.61)	Art viewing 70.63 (116.26)	Art viewing 2.05 (129.02)
	n=9; z=-2.43	n=7; z=-2.37	n=6; z=-1.57	n=6; z=-0.31	n=6; z=-1.05	n=6; z=-1.57
	p=0.015*; r=-0.57	p=0.018; r=-0.63	p=0.116; r=-0.45	p=0.753 r=-0.09	p=.917; r=-0.30	p=0.116; r=-0.45
After *vs* before	After 35.92 (28.61)	After 54.05 (48.73)	After 33.62 (32.43)	After 101.48 (94.74)	Singing -20.09 (69.39)	Singing 37.76 (59.27)
	Before 37.87 (53.84)	Before 12.27 (19.96)	Before 29.77 (27.57)	Before 58.22 (92.61)	Art viewing 3.85 (43.81)	Art viewing 43.26 (159.37)
	n=9; z=-0.78	N=7; Z=-1.86	n=6; z=-0.31	n=6; z=-1.15	n=6; z=-0.94	n=6; z=-1.05
	p=0.859; r=-0.18	p=0.063; r=-0.50	p=0.753; r=-0.09	p=0.249; r=-0.33	p=0.345; r=-0.27	p=0.917; r=-0.30
During *vs* after	During 192.53 (166.18)	During 95.62 (66.35)	During 100.39 (136.15)	During 60.27 (64.84)	Singing -95.02 (47.97)	Singing -26.20 (31.00)
	After 35.92 (28.61)	After 54.05 (48.73)	After 33.62 (32.43)	After 101.48 (94.74)	Art viewing -66.78 (147.38)	Art viewing 41.21 (62.97)
	n=9; z=-2.67	N=7; Z=-1.86	n=6; z=-0.73	n=6; z=-1.15	n=6; z=-0.73	n=6; z=-2.20
	p=0.008*; r=-0.63	p=0.063; r=-0.50	p=0.463; r=-0.21	p=0.249; r=-0.33	p=0.463; r=-0.21	p=0.028; r=-0.64

*p<0.015 (Bonferroni corrected significance level)
[a]These figures refer to change in mean scores

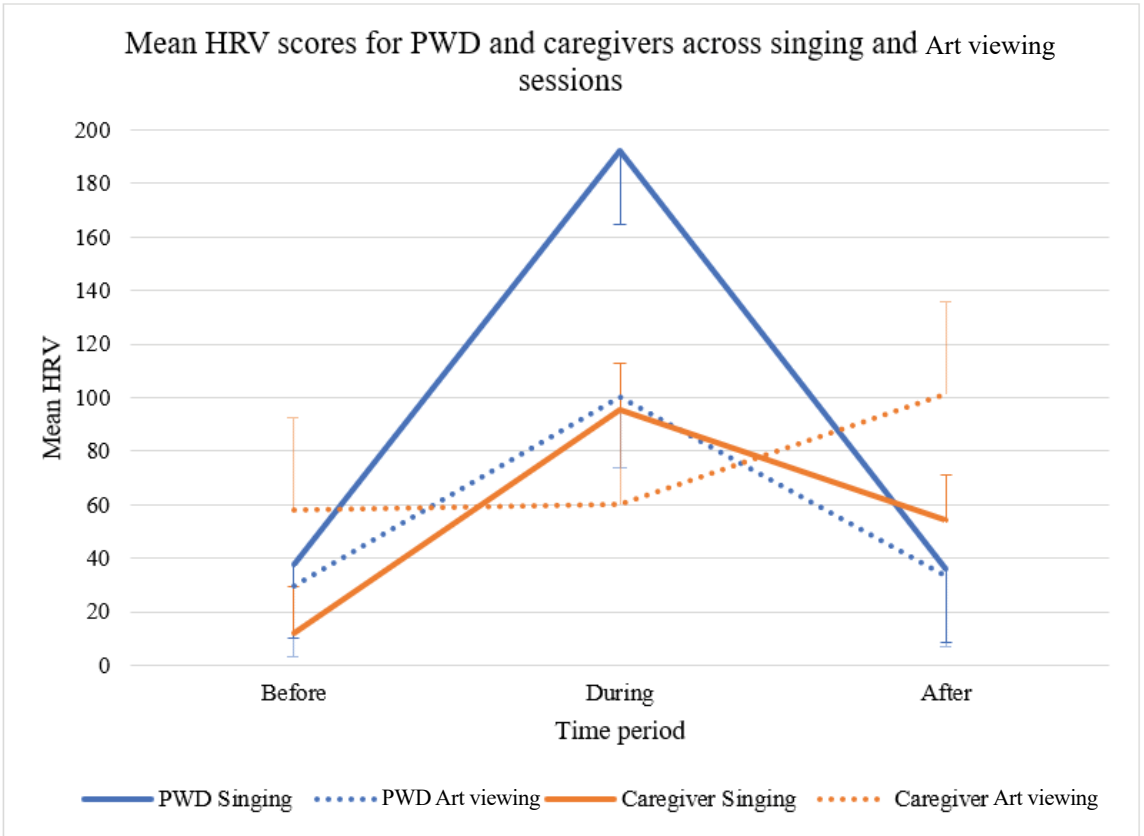

Figure 1: Mean heart rate variability scores for PWD and caregivers

Hypotheses 2 and 3 were not supported. Following the singing session, both PWD and caregivers had predicted, but non-significant decreases in subjective stress and cortisol levels. The directions of change in cortisone levels following the singing session were mixed. PWD had a non-significant increase in cortisone and caregivers had a significant decrease in cortisone, similar to previous findings in healthy populations [31].

On reflection, it could have been anticipated that there would not be a significant decrease in subjective and hormonal stress following the singing session. As the group was an ongoing activity that was reported to be enjoyable it would not be expected that participants would be particularly stressed prior to the group. If some participants had experienced recent stressful life events it may be likely that their scores would decrease more due to higher stress levels beforehand, however this information was not collected. PWD reported a significant increase in stress following the art viewing session but this may have been due to disappointment that they were not singing rather than related to the art viewing activity.

Hypothesis 4 is partially supported. There was significantly greater HRV during the singing session compared to baseline and post-session for PWD. However, for caregivers this was only approaching significance following Bonferroni correction. Also, the variance was not significantly greater than the art viewing session. The findings may suggest, and this could be explored in a longitudinal study, that PWD were emotionally engaged in the singing session and this had an impact on HRV. A recent pilot study looking at the relationship between HRV and the emotional states of happiness and sadness found a positive association between HRV variables and each emotional state [59]. In the singing session those with a dementia were the only group-session combination in which both significant effects of subjective happiness and significant increases in HRV were observed.

Subjective stress remained relatively stable, with no participants reporting difficulty completing the measure and the majority indicating slight, non-significant decreases in stress, providing support that a VAS-style stress measure can be incorporated into studies where stress measurement is being considered. If forgoing the use of stress hormones for reasons of cost and complexity (of collection, materials, storage and laboratory analysis), using a subjective stress measure appears to be a feasible way of assessing stress in this population.

Future research considerations

In addressing the feasibility of using different measures, the following needs to be considered:

(1) In response to the methodological difficulties encountered with saliva collection, if saliva assays are to be used, an alternative form to collect saliva (passive drool method) is recommended, increasing the likelihood that more saliva will be gathered for a viable analysis [33]; this approach also allows a visual assessment of how much saliva has been collected whereas chewing a swab does not. Additional considerations include being aware that high (30°C/86°F) external temperatures may result in dehydration making sample collection problematic.

(2) The Empatica E4 wristband proved easy to attach without any objections and did not interfere with either intervention according to participant reports. In addition to HRV, the Empatica E4 has the capability of measuring Sympathetic Nervous System Arousal, Emotion-Based Activity and Skin Temperature (ST), all of which have relationships to both stressful and enjoyable experiences and could easily be incorporated into future research.

The present feasibility and small-scale pilot study provide support for additional research in this area. A longitudinal, between-subjects study using physiological and subjective measures collected over multiple intervention and control sessions would provide important information about physiological responses over the course of early and middle stages of the dementias but would also be important information to know during later stages of dementias when verbal reports become more difficult to obtain and questionnaires lack validity and reliability. As impairment of PWD increases, sensor-based physiological measures have the potential to provide valuable information about psychophysiological functioning. The addition of wearable sensors during studies that use qualitative and observational and video methods would also provide further insight into how physiological responses are understood, reported and interpreted by those with dementia and their caregivers. Being able to employ a non-intrusive sensor to tap into internal bodily responses, whilst not interfering with the activity under investigation (e.g. singing, painting, and gardening, talking in a group) would be a methodological advance in further understanding how continuous involvement in any activity is responded to by people with different dementias, across levels of impairment and time.

Conclusion

The present feasibility study lends support for the use of subjective stress and wellbeing measures along with innovative, non-intrusive physiological measures in research with people with a dementia and caregivers. The use of physiological measures, in particular those that are non-intrusive and can collect continuous data over a specified time period, show promise to be used in different arts activities as well as a range of other creative activities [60]. The ease of obtaining sensor-based data was a particular contribution and a methodological advantage that should be explored in future studies. Using subjective quantitative measures along with objective physiological measures may also allow for a more nuanced understanding of physiological changes in a dementia population. Further investigation is needed to address the difficulties obtaining sufficient amounts of saliva for analysis.

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Conflict of Interest

None by any of the authors. We did not receive financial support from the manufacturers of equipment used in this study nor did we benefit in any way, financial or otherwise, by using them.

Ethics Approval

Canterbury Christ Church University Ethics (file number: V:\075\Ethics\201516)

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