Using Robotic Companion Pets To Mediate Behavioral and Emotional Symptoms of Sundowner's Syndrome in Alzheimer's Disease

A Thesis in Psychology

by

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Abstract

Alzheimer's Disease (AD), a neurodegenerative disorder associated with declining cognitive abilities, is increasing relative to the increase in average life expectancy. As a result, the cost of treatment for this population is beginning to strain caretakers and the economy. The lack of a reliable and inexpensive pharmaceutical intervention has led to the implementation of nonpharmacological therapies, specifically, robotic companion pets (RCPs). With the intent of expanding the literature surrounding aspects of AD, such as agitation, emotional distress, and Sundowner's Syndrome (SS), RCPs were used in this study to investigate their potential as an alternative to medication in treating emotional and behavioral disturbances. Eight residents with suspected AD were given RCPs to assess longitudinal changes in the discrepancy between agitation and observed emotions during non-sundowning and sundowning periods. Residents showed increases in pleasure and alertness with declining agitation and negative emotions, with a trend in discrepancy reduction regardless of whether residents experienced SS. Additionally, although each resident had varying responses to the RCPs, they were effective in fostering social interaction. These observations suggest that RCPs are a viable tool for treating emotional and behavioral disturbances in AD, serving as a cheaper alternative to pharmacological interventions.

Introduction

Dementia

Dementia refers to a group of neurodegenerative diseases that result in diminishing mental and physical capabilities due to abnormal changes to brain structures. Decaying synaptic pathways limiting neural communication will eventually impair an individual's ability to perform tasks necessary for daily functioning and autonomous living. The progressiveness of dementia means that symptoms will continually worsen without a true cure, leaving family and friends feeling as if they no longer recognize the person in front of them (Loh, 2023). Symptoms of cognitive decline affect various aspects of mental functioning, including but not limited to deficits in short-term memory, mood alterations, disorientation, language comprehension and production difficulty, poor judgement, and irrational behavior (Alzheimer's Association, 2025).

Approximately 55 million people have a clinical dementia diagnosis, with 10 million new cases being reported every year. This number is expected to increase to roughly 139 million by 2025. Due to the rapid increase in dementia diagnoses, the cost of care for treatment is becoming exceedingly expensive, reaching $360 billion in 2024. However, accounting for the approximately 18.4 billion unpaid hours spent by family caregivers, this number is increased by an additional $346.5 billion. With a lack of reliable and inexpensive treatment, this total cost of care is projected to reach $1 trillion by 2025 (Alzheimer's Disease Facts and Figures, 2024). There is an evident relationship between increasing age expectancy and increasing dementia diagnoses, making this one of the fastest-growing demographics currently. As the number of dementia cases continues to increase, so does the need for caretakers and effective treatments, however, memory care is already an under-supported, underfunded, and understaffed industry.

Furthermore, cases of dementia may be underreported. Besides the fact that a true dementia diagnosis is only obtained postmortem, there are several obstacles to obtaining a diagnosis while the individual is alive. Generally, there is a lack of knowledge and awareness of the signs of dementia progression, with behavioral and emotional changes being attributed to the normal course of aging. Once symptom progression requires medical involvement, it may be too late for intervention, a healthcare plan, recommendation on living facilities, or finding a caretaker. In addition, other obstacles include limited access to health care, remote locations, language barriers, transportation, and financial insecurity (Webster, 2021). A late diagnosis leaves families incapable of providing proper care, often forcing them to take on the responsibility of caretaker. There is a global, economic, and individual challenge in dementia treatment stemming from a lack of resources, money, and knowledge, making it necessary to research interventions to ease this strain.

Although dementia is presented as its own diagnosis, it is an umbrella term for various types of neurodegenerative disorders with differing onsets and symptoms. Vascular dementia is associated with damaged blood vessels in the brain due to oxygen deprivation, while Lewy body dementia is due to protein build-up in the brain. Parkinson's Disease and frontotemporal dementia are both caused by excessive neuronal degeneration in different brain regions. While Parkinson's Disease causes difficulty in motor control resulting from a reduction in dopaminergic neurons in the substantia nigra, frontotemporal dementia is due to the deterioration of the frontal and temporal lobes (Loh, 2023). However, the most common form of dementia that is responsible for the worldwide increase in prevalence is Alzheimer’s Disease (AD).

Alzheimer’s Disease

AD is a highly complex disorder with multiple etiologies and pathologies, making it difficult to implement preventative measures and universal treatment. A coherent understanding of AD includes the knowledge that onset and progression result from genetic, environmental, biological, and age-related factors. For instance, a normal aging process that naturally results in neural and vascular degeneration can be unnaturally exacerbated by various genetic and environmental factors, leading to inflammation, synaptic disruption, mitochondrial dysfunction, and a compromised blood-brain barrier. These biological disturbances inadvertently increase the production of the secondary products of neuronal degeneration: amyloid-beta plaques and neurofibrillary tau tangles. Plaques and tangles will continually accumulate and spread along neural pathways, disrupting brain functioning. The culmination of these factors produces the deterioration of cognition and identity seen in AD (Armstrong, 2013; Griffiths & Grant, 2023; Sochocka et al., 2017; Sheppard & Coleman, 2020).

In addition to cognitive impairment and memory decline attributed to AD, more than 90% of diagnosed patients also exhibit behavioral and neuropsychiatric symptoms that are associated with increased mortality and caregiver burden (Anatchkova et al., 2019). While cognitive impairment includes poor memory, judgement, and decision making, neuropsychiatric symptoms are non-cognitive alterations to brain function, mood, and emotion. Emotional symptoms in AD include depression, apathy, and aggression in addition to psychosis and sleep dysregulation. These symptoms manifest in early diagnostic onset and are exceedingly present in late-stage AD relative to the progression of the disease, and are reported to increase temporarily during the evening (Lyketsos et al., 2011).

Behavioral and psychological symptoms can be a consequence of neuropathic symptoms. Standardized measures, such as Neuropsychiatric Inventories, show that 90% of people with AD

have behavioral and psychological disturbances. Specifically, 17% account for psychotic outbreaks, 32% include delusions, 36% are disagreeable, 44% have expressive episodes, 56% develop tremors, and 56% show reduced ability to concentrate (Fernández et al., 2010). Studies have demonstrated a negative correlation between behavioral, psychological, and non-cognitive symptoms with cognitive impairment, meaning that symptom frequency is associated with the rate of mental decline. Patients who exhibit heightened behavioral symptoms due to AD tend to have accelerated rates of cognitive decline, a poorer quality of life, higher frequencies of institutionalization, and increased financial burden (Fernández et al., 2010). Although the symptoms cannot be eliminated since the underlying cause is a result of neuronal atrophy, they can be superficially mediated through medication and various forms of therapy, including nonpharmacological interventions.

Behavioral and psychological symptoms tend to exhibit three different syndromes: psychosis, mood disorders, and agitation. These symptoms, especially agitation, cause more distress and impairment compared to the cognitive symptoms of AD (Panza et al., 2015). The previous definition of agitation is described as an inappropriate activity, verbal or motor, that does not seem to have an obvious source. However, this definition was altered by the International Psychogeriatric Association to describe agitation in neurodegenerative disorders. Agitation, specifically in AD, is defined as: “i) occurring in patients with a cognitive impairment or dementia syndrome; ii) exhibiting behavior consistent with emotional distress; iii) manifesting excessive motor activity, verbal aggression, or physical aggression; and iv) evidencing behaviors severe enough to cause excess disability and not solely attributable to another disorder or suboptimal care condition” (Cummings et al., 2014). Agitation in AD has clinical differences from other symptoms, such as psychosis or depression, since it can be seen independently or in

combination with other symptoms. Agitation is a version of emotional stress resulting in irritability that leads to aggressive or nonaggressive expressions of those feelings, such as physical or verbal demonstrations (Cohen-Mansfield, 2001).

Verbal aggression in AD agitation manifests as insults and shouting, while physical aggression manifests as intentional altercations such as hitting, throwing, and biting. However, behavioral and emotional responses stemming from agitation are usually harmless and void of aggression. These responses tend to be more representative of agitation-induced anxiety, manifesting as restlessness, fidgeting, motor activity, irregular vocal patterns, and pacing. (Ballard et al., 2009). Symptoms increase in severity and frequency relative to the rate of neuronal degeneration, however, they become more common when caregivers are assisting with personal care and hygiene. Due to an increase in agitation with disease progression and during vulnerable moments, further stress and labor are placed upon overworked and understaffed caretakers.

The prevalence of agitation in AD varies widely. While there are rates between 40-100% of at least one neuropsychological symptom, the prevalence rate of agitation specifically is between 5-88% (Anatchkova et al., 2019). Treatment for aggressive agitation oftentimes requires pharmacological intervention, however, behaviors of agitation associated with irritation, anxiety, and discomfort may be an adverse effect of antipsychotics, emphasizing the necessity for treatments that are not contingent on pharmacological dependency (Ballard et al., 2009).

Sundowner's Syndrome

Although the progression of neuropsychiatric symptoms in AD is relative to degeneration, it remains highly variable. Sundowner's Syndrome (SS) is the temporary increase in neuropsychiatric symptoms in the evening. Even though healthcare professionals and

caregivers acknowledge its existence, a lack of standardized assessment tools and a conclusive definition leads to disagreement on aspects of SS. SS is typically associated with abnormal increases in confusion, aggression, pacing, wandering, mood swings, hallucinations, and agitation as the sun sets, with SS-associated agitation being the most common cause of institutionalization in AD (Canevelli et al., 2016) (Khachiyants et al., 2011).

Similar to agitation, the prevalence of SS varies widely from 2.4-66% in all dementias and from 2.4-25% in AD, with 12% of all elderly patients in nursing homes demonstrating these changes in cognition and behavior during the evening (Khachiyants et al., 2011). SS is not specific to AD, however, investigation generally tends to focus on the phenomenon in this demographic since AD makes up the majority of dementias and has an SS prevalence rate higher than the general population in the same age range. Even with the wide range of SS reported in AD, the consensus is that it is at a 20% prevalence rate across patients (Canevelli et al., 2016). Main symptoms include ~56% agitation, ~54% irritability, and ~46% anxiety. There is a consensus in the literature that SS is primarily a phenomenon affecting mood, and therefore, demonstrated behavior. Even though people with comorbid AD and SS had heightened emotional and behavioral disturbances than individuals with AD who do not experience SS, neuropsychological scores were similar between both demographics. However, patients with AD and SS exhibit higher levels of cognitive impairment (Blasi et al., 2023).

Although the cause of SS is disputed, it is believed that worsening emotional and behavioral symptoms are a byproduct of cognitive impairment severity. Research agrees that this phenomenon is a multifaceted combination of various contributing factors, with several theories as to why SS develops in only a fifth of patients. Biological explanations note the possibility that alterations in the suprachiasmatic nucleus, a decrease in melatonin, and cellular atrophy may

disrupt circadian rhythm, causing emotional dysregulation that may be exacerbated by a reduction of cholinergic projections and an increase in neurofibrillary tangles. It is also a possibility that higher levels of cortisol are associated with heightened agitation (Canevelli et al., 2016).

In addition to the neurological and biological contributions to SS, there may be environmental factors that play a role in development. It is possible that evening light exposure and afternoon fatigue, which may cause or be a product of a disrupted circadian rhythm, lead to agitation and wakefulness during the evening (Canevelli et al., 2016). In addition to a disrupted sleep-wake cycle, it is equally likely that caregiver figure, morning activity, overstimulation, and a lack of routine give rise to increased agitation in the evening. In addition to unstructured regimens causing boredom, restlessness, and agitation, caregiver fatigue will worsen the quality of care they produce. These conjoined factors contributing to a decreasing quality of life in AD may have implications for SS onset (Khachiyants et al., 2011).

Medication and pharmacological treatment may also explain the prevalence of SS in AD. Treatments for mood and behavioral disturbances, such as antipsychotics and antidepressants, may unintentionally aggravate negative emotions. Furthermore, just as the presence of these medications may unintentionally exacerbate symptoms associated with SS, another possibility is that the absence of these medications may induce SS. Chronically taking medications, such as sedative hypnotics, benzodiazepines, or low-potency antipsychotics, may worsen emotion and behavior via withdrawal symptoms. For example, taking into account drug tolerance and dependency development, withdrawal and medication wear-off during the evening may put the central nervous system into a depressive stage, hypothetically worsening agitation and confusion (Khachiyants et al., 2011).

Although SS is commonly reported among caretakers, there is little known about its pathology. Even with multiple theories regarding its origin, disputes remain regarding the clinical manifestations of SS due to a lack of conducted research. Evidence supporting SS onset is lackluster due to high variability in prevalence rates and the absence of randomized control trials, leading to ideas about correlation rather than explanations of causation. More specifically, research is difficult due to a lack of a standardized definition and assessment tools (Khachiyants et al., 2011)(Canevelli et al., 2016)(Blasi et al., 2023). Furthermore, it is demanding to pinpoint the cause of onset due to it being a complex occurrence that may be derived from a combination of various neurobiological, psychological, and environmental factors.

Non-pharmacological Treatment

To avoid maladaptive side effects associated with pharmacological medication in AD, non-pharmacological treatments (NPTs) are being sought out as an alternative. Variations of NPTs range widely, focusing on verbal interaction and cognitive stimulation with or without physical objects to manage clinical AD symptoms without the negatives associated with drug intervention. Although further research is necessary, NPTs may be able to increase (or plateau) cognitive functioning while decreasing emotional disturbances and agitation. NPTs primarily fall into three categories: environmental modification, lifestyle changes, and companionship.

Sleep disturbances are a major symptom of AD, with poor quality associated with daytime irritation and nocturnal motor activity contributing to an increase in behavioral turmoil (Sikkes et al., 2020*)*. Environmentally manipulative NPTs are used to promote sleep as a tactic for agitation reduction. Sleep-wake cycles can be modified using artificial light to mimic a natural circadian rhythm to reduce daytime naps and increase nightly sleep. This can be done through bright-light therapy or photobiomodulation, where patients are placed in front of a strong

light in the former and receive direct infrared light in the latter (Alzheimer's Society, 2025). Using environmental manipulations via light therapy, sleep disturbances have shown decreases, leading to a decrease in associated behavioral issues. However, this therapy is primarily used in general nursing homes, and research is not specific to dementia or AD (Sikkes et al., 2020*)*. Another environmental modification includes active and receptive music therapy to stimulate neuronal connectivity and sympathetic arousal in dopaminergic pathways (Wang et al., 2020). Active treatments include playing instruments, singing, and dancing, while receptive treatments include listening to music. These environmental NPTs have been shown to reduce behavioral disturbances and depression, however, there were no changes in agitation or quality of life, with future research necessary to improve study designs (Sikkes et al., 2020*)*.

NPTs that focus on lifestyle changes include meditation, diet, and acupuncture. There is a wide range of benefits associated with the implementation of mediation into a daily routine. For instance, regular mediation has been shown to reduce inflammation and stress through alterations to neuronal connectivity, changes in glucose metabolism, and improvements in microscopic and macroscopic brain structures. Combined, these improvements in brain structures have the combined effect of emotional regulation and well-being (Sikkes et al., 2020*)*. However, even though this practice is implemented in memory care facilities, there are no systematic reviews or randomized controlled trials regarding dementia and AD treatment, calling into question the applicability to this demographic. On the other hand, diet alterations have shown benefits in AD by increasing micronutrient and macronutrient consumption to favor vitamins, protein, fat, and carbohydrates. Specifically, vitamin B for memory performance, flavonol for cognitive performance, and vitamin E for mental decline reduction (Sikkes et al., 2020*)*. These nutritional additions work via reducing oxidative stress, improving vascular health, and strengthening neural

cell communication (Miller et al., 2005). Another NPT that shows promise for AD treatment is acupuncture. Research suggests that this practice can improve dendritic structure and axonal regeneration to improve spatial learning and memory. For AD, there are supposedly benefits to cognitive function by reducing alpha-beta protein deposit and glucose metabolism while increasing neurotransmission (Wang et al., 2020). However, conclusions are inconsistent and future research is necessary to determine causation in this NPT.

Although environmental modification and lifestyle changes suggest improvements for AD treatment, another component of the disease is social isolation. Companions, in the form of therapy animals and baby dolls, can provide a source of connection and emotional bonding that acts as a substitution for the loss of intimate relationships in nursing homes or memory care facilities, where patients are removed from their primary social circles. Animal-assisted therapy (AAT) is an NPT based on dampening physical pain manifested from the psychosomatic distress of emotional and psychological strain due to social withdrawal (Cevizci et al., 2013). Implementation of AAT shows emotional improvements leading to reduced behavioral disturbances such as agitation, aggression, stress, depression, and anxiety with correlational increases in self-esteem, communication, and quality of life (Filan & Llewellyn-Jones, 2006) (Tribet et al., 2008). Furthermore, there are implications for AAT in improving cognitive decline in AD, with average mini mental status exam score increasing after treatment (McCabe et al., 2002). There are issues associated with live animals residing in memory care facilities, however, concerns surrounding hygiene, safety, and care can quickly be eliminated when using doll therapy (DT). DT is used as a person-centered NPT that takes concepts from Bowlby's theory of attachment, fulfilling the need for emotional connection and human interaction that allows for patients to relate to the external world (Pezzati et al., 2014). DT has shown improvements in AD

in cognitive functioning, language, and memory, with reductions in agitation, irritability, and distressing psychological, behavioral, and emotional symptoms (Balzotti et al., 2018). However, there are concerns about the morals relating to DT regarding whether or not it is ethical to present dolls to people with AD who are under the impression that they are real babies. While some critics say that it is ethically responsible to inform patients that the dolls are not real, researchers argue that there is more harm in disrupting the patient's perception of reality if DT shows positive effects.

Robotic Companion Pets

The complications associated with AAT and DT regarding safety concerns and ethical dilemmas can be solved with the implementation of robotic companion pets (RCPs). RCPs are programmed cat and dog toys that are designed with the intent of mimicking the behaviors of real animals. They respond to feedback from the recipient and provide constant interactive stimulation through multisensory auditory and tactile sensations. Interaction of the recipient will facilitate responses from the RCP, creating a feedback loop of constant stimulation since attention and focus will be constantly shifted back towards the stimuli.

Research concerning the potential use of RCPs has primarily been qualitative findings that extract themes from observational analysis. Despite the lack of studies conducted, quantitative data regarding this NPT is becoming more prevalent in recent years. In AD, RCPs have been demonstrated as an effective NPT, improving mood, behavior, and mini-mental status scores (LaRose et al., 2021). Furthermore, they show significant reduction for anxiety and agitation in people with AD through providing them with a sense of comfort and a source of connectivity (Marsilio et al., 2018).

Even with more research being conducted, there still lacks a substantial number of randomized controlled trials to solidify the correlation between RCPs and mediation of emotional and behavioral disturbances. Similarly, no previous study has taken the role of SS into consideration when testing the effectiveness of RCPs, meaning that data from these observational studies could be altered depending on the time of day the experiments were conducted. The following paper will go into detail about the role of RCPs in mediating symptoms of AD, with an emphasis on SS.

Methods

Participants

Eight female residents with suspected AD from Fox Trail Memory Care Facility in Montville, New Jersey, participated in this six-week observational study. Fox Trail is a specialized facility that houses residents with memory impairments due to trauma or neurodegeneration. Residents primarily comprise elderly individuals with AD who can no longer be cared for by their family members, transferring caretaking responsibilities to trained medical technicians, practitioners, and nurses. While there were approximately 13 residents at this location, only 8 met the criteria for eligibility. To be eligible for this study, residents had to i) possess a diagnosis of suspected AD, ii) not have a diagnosis that has progressed to the point where intervention would be ineffective, iii) show interest in the RCPs, iv) be willing to participate, and v) have consent from their power of attorney.

In compliance with confidentiality and HIPAA regulations, reports of resident medical history could not be utilized for this study. Therefore, AD stages and progression rate were based on caretaker observation. Prior to the beginning of the study, approval for the study was received

from Fox Trail Memory Care, the Institutional Review Board of Drew University, and the residents' power of attorney.

Materials

Six RCPs were used in this study, five were robotic cats and one was a dog. Fox Trail already had the dog and two cats in their possession, with the remaining RCPs donated by the company Ageless Innovation Joy For All. To examine resident agitation and emotions while interacting with the RCPs, the Cohen-Mansfield Agitation Inventory (CMAI) short form and the Observed Emotion Rating Scale (OERS) were used and modified during observational periods (see Appendix). During observational periods of 20 minutes of using the CMAI and OERS, qualitative data were also collected. Qualitative data includes notes concerning resident action, behavior, and interaction with the RCP and other residents, with these observations noted to account for emotion and behavior that was not accounted for by the previously stated measures.

The CMAI is a standardized tool to measure the frequency and intensity of various behaviors that are representative of agitation. This inventory is used in elderly populations, primarily with AD, to track longitudinal changes of patients using pharmacological or non-pharmacological interventions to monitor the treatment's impact on problematic behaviors. The standardized CMAI has 29 items that are grouped in 14 categories in the short-form. Categories include varying behaviors such as verbal aggression (yelling, cursing, negativism, etc.), physical aggression (hitting, kicking, throwing, self-abuse, etc.), and non-aggressive behaviors (pacing, restlessness, strange noises, repetitive motions, etc.). The CMAI was used during observation periods of 20 minutes, ranging from a scale of 1-5, with 1 representing an absence of behavior and 5 indicating continuous displays.

The OERS was used at the same time as the CMAI during observation periods. The OERS is a standardized measure that focuses on the observable emotions that residents display at a given moment in time. This measure is useful in studies of AD when assessing emotional state since residents are not required to give an introspective report on their emotions. The OERS tracks longitudinal changes in emotion to evaluate well-being and provide insight into treatment effectiveness. There are five emotional categories and defining characteristics: pleasure (smiling, laughing, etc.), anger (frowning, verbal intensity, etc.), anxiety or fear (restlessness, distress, etc.), sadness (crying, looking down, lack of expression, etc.), and general alertness (signs of awareness, environmental engagement, holding conversations, etc.).

Design

This investigation was a cohort study of how residents in a memory-care facility would respond to the presence of RCPs, recording behavioral measures outside of a laboratory setting. The two independent variables examined were the presence of the RCP and time of day. Additionally, the two dependent variables measured were levels of agitation and demonstrated emotions during this period. Eligible participants shared the 5 RCPs amongst themselves during their observational period. However, since there were few participants initially, there was no randomization of trial conditions. Additionally, it was impractical to conduct a double-blind study since it was impossible for the observers to be blind to the conditions due to the presence of RCPs and the time of day being easily visible. During observation periods, there were two observers who did not have contact with the residents and one helper who provided the residents with either a blanket during baseline-measurements or the RCP during intervention-measurements. Residents were aware of the observers' presence at a distance, and

while interaction was not initiated by the observers, if a resident began a conversation the observers would respond.

Observers took precautions prior to the study to ensure there were minimal bias and confounding variables during periods of observation. Before observation periods began, observers spent a week at Fox Trail to make themselves familiar with the residents to make sure that emotion, behavior, and agitation shifts throughout the study were not due to residents becoming stressed and then more comfortable with their presence. During this week, residents no longer showed signs of uneasiness or suspicion concerning the observers, and observers practiced using OERS and CMAI scales to secure interrater reliability and consistent measurements. During baseline measurements, the blanket was used as a stand-in for the RCP to ensure that the residents were responding to the stimulus during the treatment period, not to the presence of the helper. However, once the treatment period began, 5 RCPs had to be shared among 8 participants. Since there were not enough RCPs to allow each resident to have their own, a dosing approach was taken. During observation periods, residents were only given the RCPS during their observation periods, meaning that acute effects of the treatment were observed.

The study took place over the course of five weeks, with a total of twelve observation days. During the baseline week, observers spent four days measuring how residents acted normally once the helper handed them a blanket. During the treatment weeks, observers spent eight days measuring how residents acted after the helper handed them the RCP. The first four and last four observations with the RCP were averaged together to make two additional time periods for a combination of three data points: baseline observations (without RCP), midpoint observations (with RCP), and final observations (with RCP).

Procedure

During observation periods, residents were observed two times a day. The first observation took place after breakfast between 9:00 am and 12:00 pm for pre-sundowning data. The second observation took place after dinner between 5:00 pm and 8:00 pm to collect sundowning data. During these periods, each resident was observed for twenty minutes with the RCP, where the CMAI and OERS were used at the same time. In addition to quantitative scales, observers noted down qualitative observations of the residents. Observations consisted of noting behaviors performed and emotions displayed that neither scale addressed. Post-treatment after data collection, staff, nurses, and medicine technicians at Fox Trail were interviewed to see if they had noticed a change in resident behavior.

Observations took place in the main living room and dining area of Fox Trail. If a resident began to wander inside or outside the facility during their observation period, observers would follow them around without interfering until the time frame concluded. Additionally, if residents decided they no longer wanted the RCP at any point during the observation, the helper would take it back, but the observer would continue until the twenty minutes concluded. However, if a resident was in their room or decided they wanted to go into their room during the observation period, observers did not follow them into the room to respect privacy and personal space. Due to this boundary that was set in place, if a resident decided they didn't want to leave their room the entire day, we did not observe them. Therefore, most residents have a few days during which no data were collected.

Results: Quantitative

Due to variables including the limited number of participants in the sample size, the lack of consistent data from each of the residents due to privacy restrictions, and issues with attrition

due to death or illness, there are no statistically significant differences in comparisons of interest. Throughout the course of the study, one participant was put into hospice care and another passed away.

Agitation

A characteristic of note is an overall low level of agitation regardless of condition. Moreover, there are minimal differences between agitation levels during the morning (non-sundowning) and evening (sundowning) period. Consistent through the five-week observation period, levels of agitation decrease incrementally and minimally without noticeable differences.

Figure 1 shows minimal evidence for sundowning, demonstrating a 0.02, 0.07, and -0.01 point discrepancy between morning and evening agitation levels during the baseline, midpoint observation, and final observation data points, respectively. Furthermore, results remained insignificant for longitudinal decreases in agitation, with a 0.16-point decrease in morning agitation and a 0.19-point decrease in evening agitation from the baseline to the final observation period. However, although agitation levels began low, it is of note that they dropped until they were hardly present during the final observation.

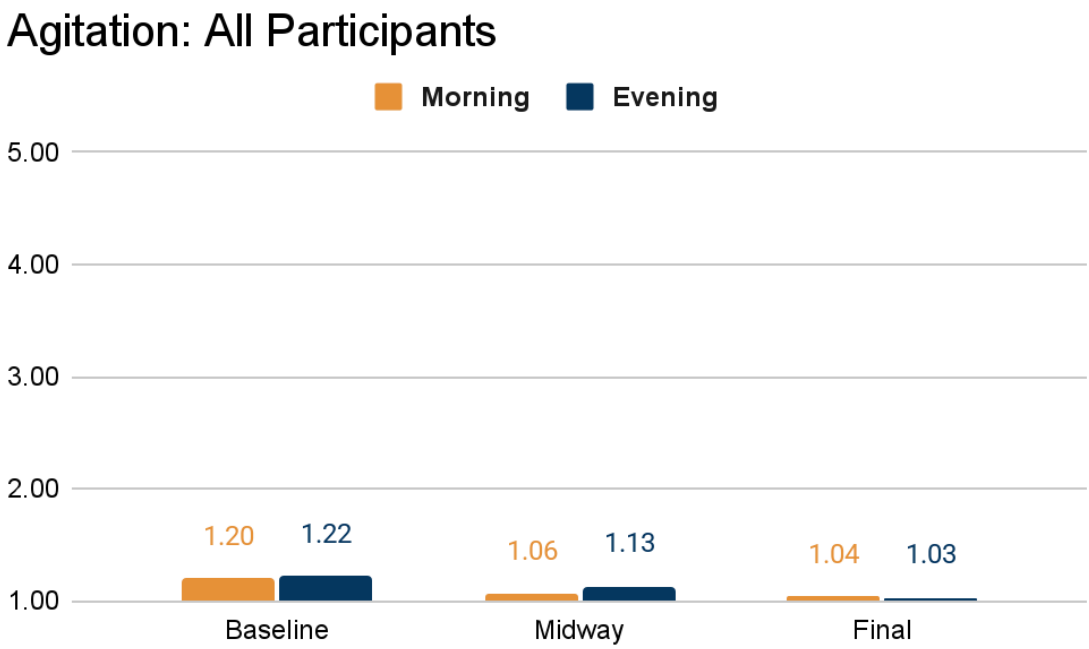

Figure 1. *Average Morning and Evening Agitation Scores for All Participants*. The Cohen-Mansfield Agitation Inventory Short-Form was used to collect scores of agitation quantified by behavior in the morning and evening during baseline, midway, and final observations. Participant scores were averaged and show an insignificant trend of declination. There were 8 participants in baseline measurements, and 7 for the final morning with 6 for the final evening.

Consistent with the evidence that AD is highly variable with volatile expressions of agitation, results were weighted down since not every resident experienced the same variations and intensity of agitation than what is listed on the CMAI. Therefore, removing items from the CMAI on an individual basis if that item was never expressed presents a more comprehensive image of resident agitation, sundowning, and RCP effectiveness. During data analysis, each item on the CMAI that did not appear throughout baseline measurements and both manipulation

periods was removed from the individual total score, recalculating the agitation inventory to exclude expressions that were never exhibited.

Figure 2 shows evidence for the presence of sundowning among (some of) the residents, demonstrating a 0.15, 0.19, and -0.16 point discrepancy between morning and evening agitation levels during the three time periods. Although low, scores of agitation are more representative of each resident's experience of AD, and a moderate demonstration of the RCP effectiveness is shown. Results for agitation showed a declining trend, with a 0.47-point decrease in morning agitation and a 0.78-point decrease in evening agitation from the baseline to the final observation period. Using Cohen's d for statistical analysis, it was determined that the effect size for the decline in morning agitation among all participants from the baseline to final observation period was 0.56 and the effect size for the decline in evening agitation was 1.26. These numbers reveal a moderate and a large reduction in morning and evening agitation levels respectively. With irrelevant CMAI items removed, results show a holistic image of residents with AD, their heightened agitation during the sundowning-period, and their positive response to the RCP.

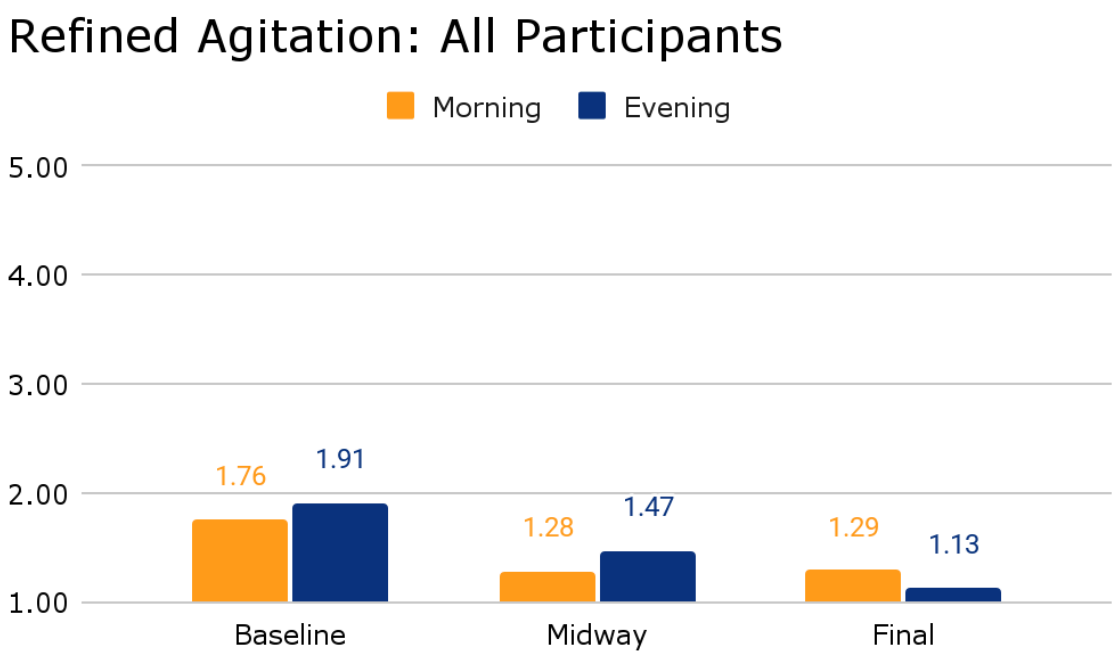

Figure 2. *Refined Morning and Evening Agitation Scores for All Participants*. Irrelevant items from the Cohen-Mansfield Agitation Inventory Short-Form were removed. The remaining numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. Scores show a more promising trend of declination and hint at the presence of Sundowner's Syndrome with heightened evening agitation during the baseline.

Just as AD is a variable disease, so is the presence of SS. Using the data, residents can be split into two groups to determine if the RCP has a similar effect on agitation reduction between both demographics. Individuals classified as ‘sundowners’ experienced levels of agitation during the evening that exceeded levels of agitation during the morning. Individuals classified as ‘nonsundowners’ had levels of agitation during the evening that were equivalent to, or lower than, levels of agitation during the morning. Out of the 8 participants, 5 residents were sundowners while the remaining 3 were non-sundowners.

Figure 3 shows that agitation during the evening is more pronounced with sundowners compared to the conjoined group average seen in Figure 2. During baseline measurements, there

is a higher discrepancy between morning and evening levels of agitation. However, during the study's progression the difference between morning and evening agitation becomes less striking, showing the RCP's effectiveness in minimizing the effects of SS. There is a 0.38, 0.20, and 0.05 point discrepancy between morning and evening agitation levels during the three periods. Consistent with the other graphs, there is a trend of decreasing overall agitation with the RCP. For sundowners, there was a longitudinal decline in agitation, with a 0.16-point decrease in morning agitation and a 0.49-point decrease in evening agitation from the baseline to the final observation period. The effect size for sundowner agitation decline was 1.10 for the morning and 2.60 for the evening, indicating a strong and meaningful reduction. Overall, sundowners had heightened levels of evening agitation compared to morning agitation, with the RCP decreasing the discrepancy and overall levels of agitation.

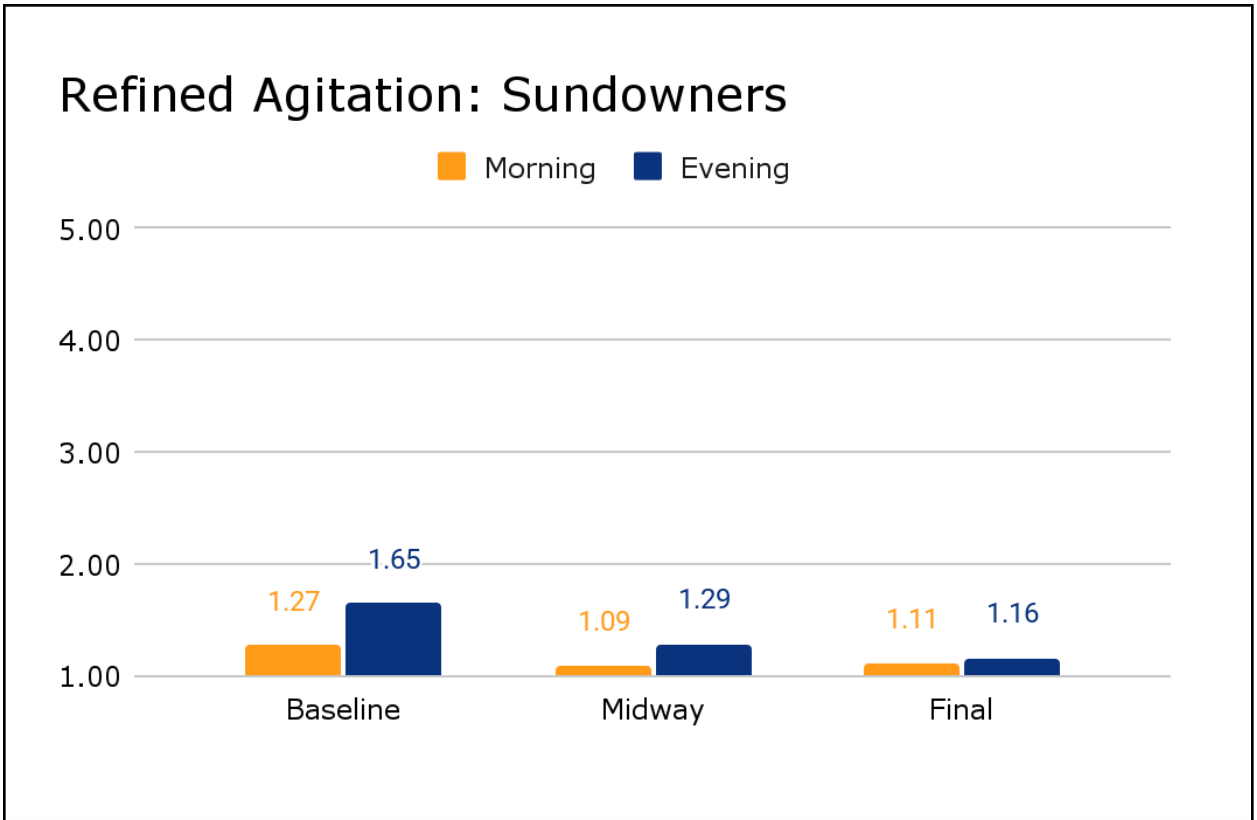

Figure 3. *Refined Morning and Evening Agitation Scores for Sundowners*. The refined scores

from the Cohen-Mansfield Agitation Inventory were split to show the individuals who experience Sundowner's Syndrome. There were 5 individuals during baseline observations, with 4 during the final morning and 3 during the final evening. There is a trend of declining agitation throughout the study.

Unlike sundowners, non-sundowners do not show heightened levels of agitation during the evening. Agitation is either constant throughout the day or slightly higher during the morning. Figure 4 shows that agitation levels in non-sundowners are higher in the morning. Surprisingly, overall agitation levels are considerably higher in this demographic. There is a -0.23, 0.17, and -0.42 point discrepancy between morning and evening agitation levels during the three time periods. There is also a trend of decreasing overall agitation with the RCP. For non-sundowners, there was a longitudinal decline in agitation, with a 1.06-point decrease in morning agitation and a 1.25-point decrease in evening agitation from the baseline to the final observation period. The effect size for non-sundowner agitation decline was 0.89 for the morning indicating another strong reduction and 0.72 for the evening showcasing a moderate effect. Non-sundowners also showed positive responses to the RCP, even though they showed generally higher levels of agitation throughout the study, however, the discrepancy between morning and evening agitation widened.

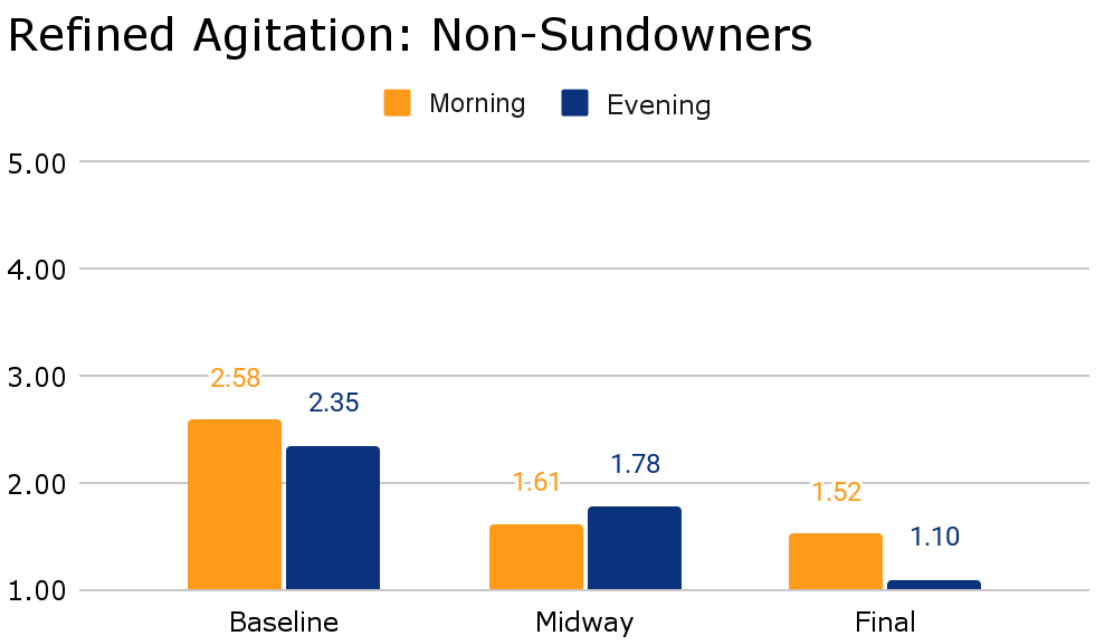

Figure 4. *Refined Morning and Evening Agitation Scores for Non-Sundowners*. The refined scores from the Cohen-Mansfield Agitation Inventory were split to show the individuals who do not experience Sundowner's Syndrome. There were 3 individuals throughout the entire observations. There is a more apparent trend of declining agitation throughout the study, with overall agitation appearing higher.

Pleasure

Unlike the CMAI, which only examines the behaviors of individuals with AD that are expressed due to feelings of agitation, the OERS is a comprehensive observation of emotions such as pleasure, anger, anxiety or fear, sadness, and general alertness. The OERS scale data were also divided between sundowners and non-sundowners based on the criteria from the CMAI to look at the effects of the RCPs on participant emotions. Signs that a participant is experiencing pleasure include expressed behaviors of: laughing, singing, smiling, kissing, stroking or gently touching others, reaching out warmly to others, or responding to music.

Figure 5 shows the levels of perceived pleasure in sundowners, with increasing levels after introducing the RCP. Surprisingly, the RCP does not eliminate the discrepancy of pleasure, with there being higher levels exhibited during the evening. The graph demonstrates a 0.35, -0.6, and 0.91 point discrepancy between morning and evening pleasure during the three data points. Furthermore, there is a trend of increasing overall pleasure with the RPC. For sundowners, there was a longitudinal increase in pleasure, with a 1.69-point increase in morning pleasure and a 2.25-point increase in evening pleasure. The effect size for sundowner pleasure increase was 1.55 in the morning and 1.53 in the evening, representing particularly strong trends. For sundowners, pleasure remains higher during the evening period with a longitudinal increase in overall pleasure with the RCP.

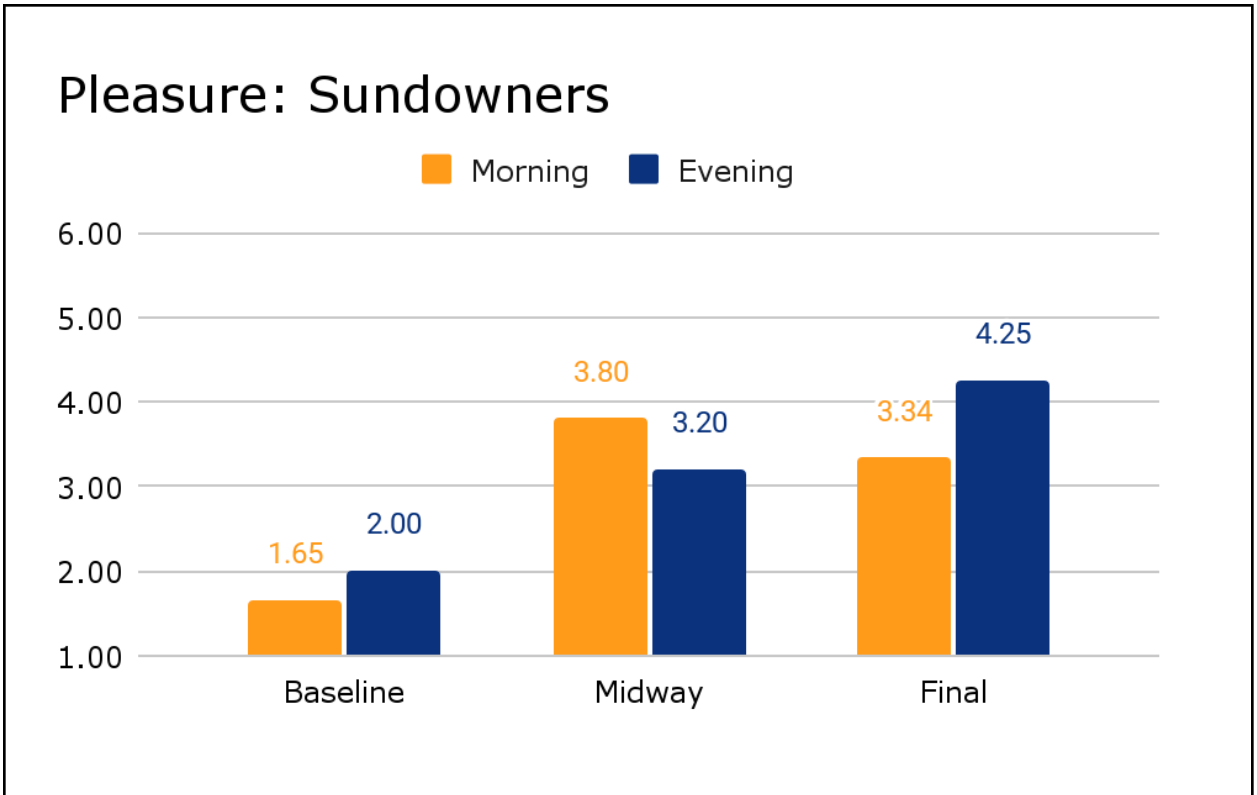

Figure 5. *Morning and Evening Pleasure Scores for Sundowners*. The Observed Emotion Rating Scale was used to quantify resident pleasure based on exhibited behaviors. The

remaining numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of increasing pleasure throughout the study.

Since non-sundowners tend to show high levels of agitation in the morning, it is expected that there would be high levels of pleasure during the evening; however, non-sundowners showed low levels of baseline pleasure during the morning. Figure 6 shows a large discrepancy in pleasure for non-sundowners that fades over time, demonstrating a -0.84, 0.25, and -0.14 points during the three data points. Similar to sundowners, non-sundowners show a trend in increasing overall pleasure. For non-sundowners, there was a longitudinal increase in pleasure, with a 0.94-point increase in morning pleasure and a 1.92 increase in evening pleasure from the baseline to the final observation period. The effect size for non-sundowner pleasure increase is 0.86 for the morning and 2.87 for the evening, representing an especially strong increase regarding evening emotions.

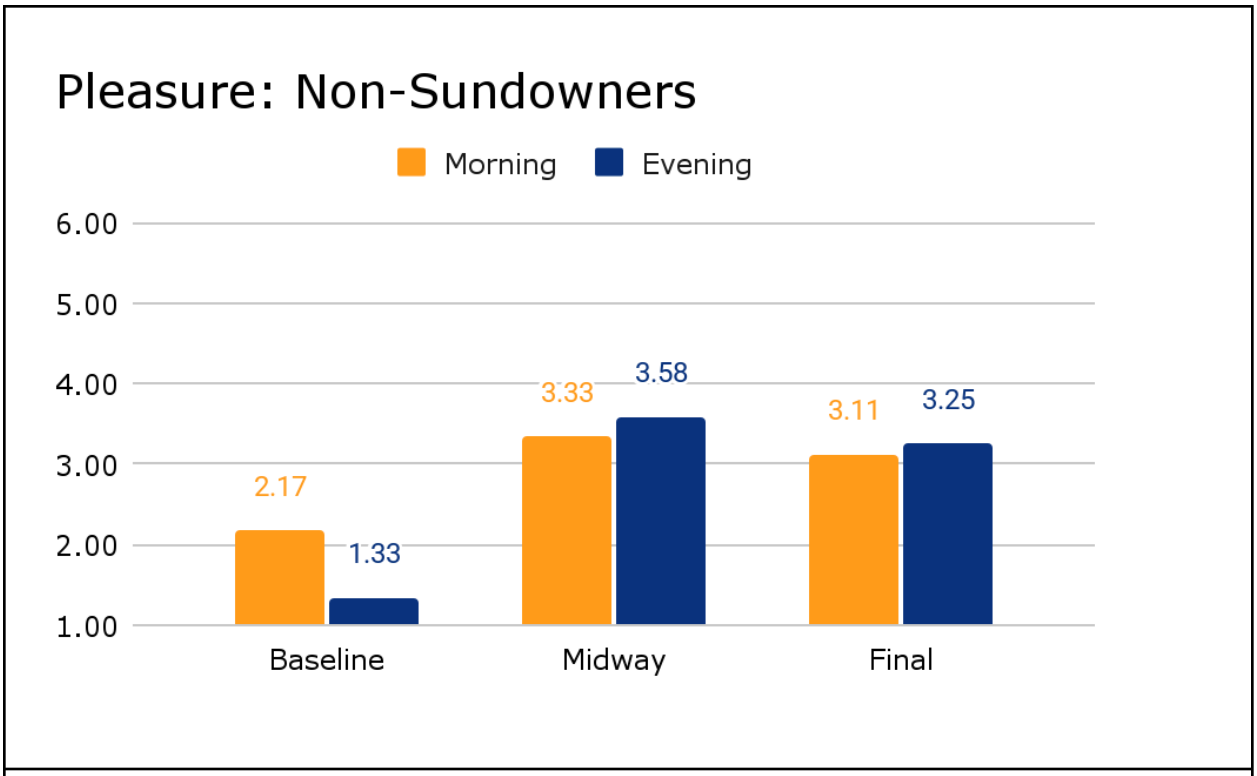

Figure 6. *Morning and Evening Pleasure Scores for Non-Sundowners*. The Observed Emotion Rating Scale was used to quantify resident pleasure based on exhibited behaviors. The remaining numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of increasing pleasure throughout the study, with a slight plateau.

Negative Emotions

Another component of the OERS includes anger, anxiety, or fear, and sadness. Signs that a participant is experiencing anger include expressed behaviors of physical aggression, yelling, cursing, berating, shaking fists, drawing eyebrows together, clenching teeth, pursing lips, narrowing eyes, and making distancing gestures. Signs of anxiety or fear include shrieking, repetitive calling out, restlessness, wincing or grimacing, repeating or agitated movement, a line between eyebrows, lines across the forehead, hand wringing, tremors, leg jiggling, rapid breathing, wide eyes, and tight facial muscles. Finally, signs of sadness include crying, frowning,

drooping eyes, moaning, sighing, head in hands, eyes or head turned down, and an expressionless face. These feelings often overlapped between residents, and it was difficult to discriminate between the emotions based on subtle displays of behavior. To have a conclusive representation of these observed feelings, these three were combined to represent the category of negative emotions.

Figure 7 shows the category of negative emotions for sundowners, demonstrating a 0.78, 0.22, and 0.03 point discrepancy between morning and evening negative emotions during the three data points. Furthermore, there was a steep decrease in negative emotions after introducing the RCP. For sundowners, there was a longitudinal decline in negative emotions, with a 0.30-point decrease in morning negative emotions and a 1.05-point decrease in evening negative emotions from the baseline to the final period. The effect size for sundowner negative emotion decrease is unable to be computed for the morning since the standard deviation is 0, but it remains large for decreases in the evening at 1.85. Sundowners experienced negative emotions during the evening nearly twice as often, however, the RCP drastically decreased the discrepancy of negative emotions, as well as nearly eliminating their frequency by the end of the study.

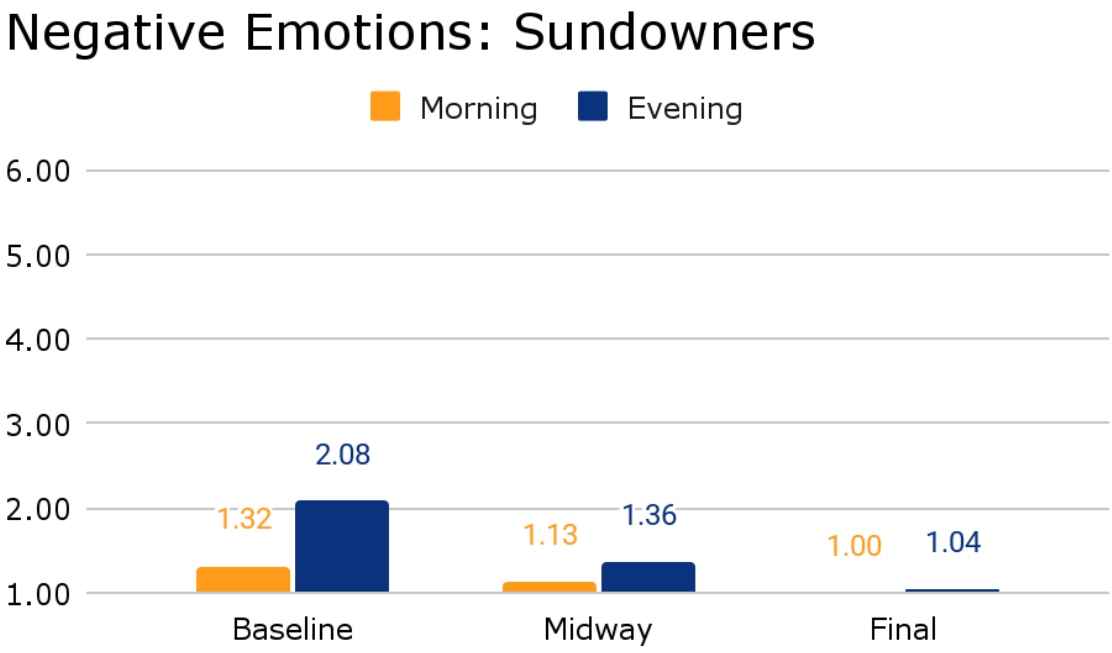

Figure 7. *Morning and Evening Negative Emotion Scores for Sundowners*. The Observed Emotion Rating Scale was used to quantify resident negative emotions based on exhibited behaviors. Negative emotions include anger, anxiety or fear, and sadness. The remaining numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of decreasing negative emotions throughout the study, showing heightened baseline evening levels declining to almost non-existent.

Data regarding sundowners and non-sundowners were similar across the negative emotions domain and continued to show similar patterns with the RCP. Figure 8 shows negative emotions for non-sundowners, demonstrating a 0.47, 0.11, and 0.14 point discrepancy between morning and evening agitation levels for the three data points. Furthermore, there continues a similar trend of decreasing overall negative emotions. For non-sundowners, there was a longitudinal decline in negative emotions, with a 0.36-point reduction in morning negative emotions and a 0.69-point decrease in evening negative emotions. The effect size for non-sundowner negative emotion decrease is especially large, with 7.20 for the morning and 1.29

for the evening. Sundowners and non-sundowners showed extremely similar patterns for this category concerning baseline levels, discrepancy trends, and decline rate. The RCP was additionally able to reduce negative emotions in both groups to nearly equivalent levels.

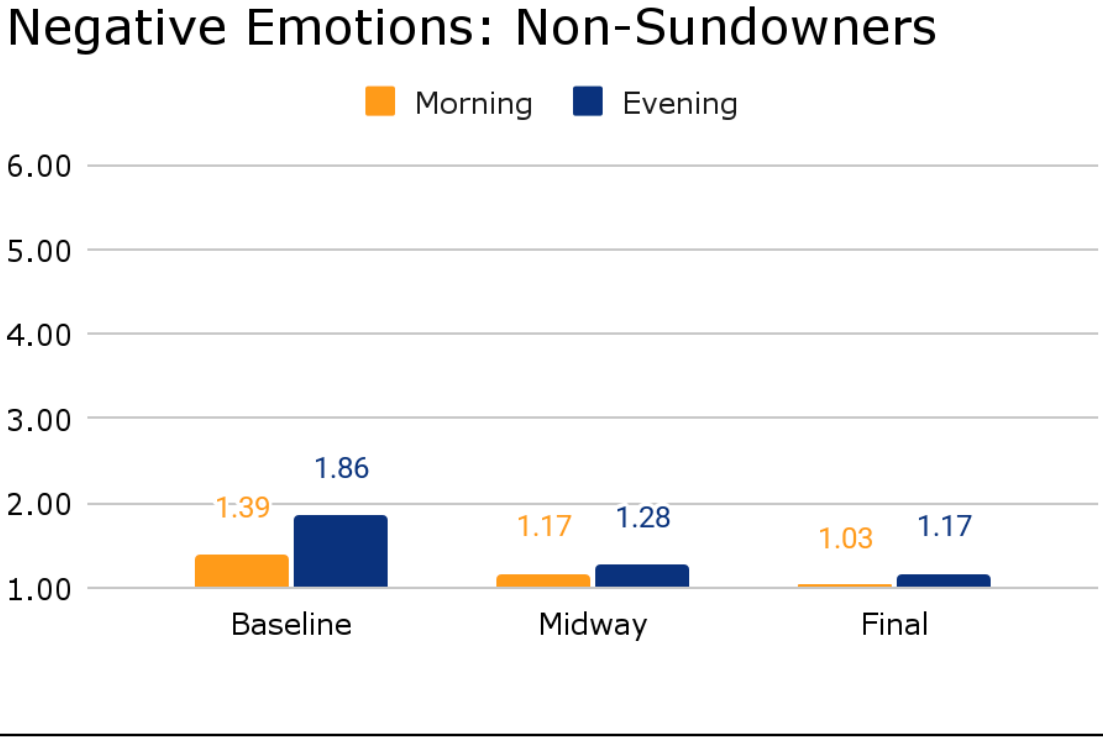

Figure 8. *Morning and Evening Negative Emotion Scores for Non-Sundowners*. The Observed Emotion Rating Scale was used to quantify resident negative emotions based on exhibited behaviors. Negative emotions include anger, anxiety or fear, and sadness. The remaining numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of decreasing negative emotions throughout the study, showing heightened baseline evening levels declining to almost non-existent. These numbers for non-sundowners show a surprising similarity to the scores of sundowners.

Alertness

The final category in the OERS is general alertness. Signs that a participant is being alert include behaviors of participating in a task, maintaining eye contact, having eyes following an

object or person, looking around a room, responding by moving or saying something, turning the body, or moving towards a person or object.

Figure 9 shows levels of perceived alertness and engagement from sundowners. This group tended to have an inconsistent trend in discrepancy ensign in a higher magnitude. Sundowners demonstrated a 1.35, 0.03, and 1.53 point discrepancy between morning and evening alertness levels during the three data points. Similarly, there is an unexpected trend in overall alertness for sundowners, with morning alertness declining while evening alertness continues to increase. Although it is not linear, there is still a trend of increasing overall alertness with the RPC. Sundowners have a longitudinal increase in alertness, with a 1.00-point increase in morning alertness and a 1.18-point increase in evening alertness. The effect size for sundowner alertness increase is 0.56 in the morning and 1.26 in the evening, showcasing another moderate and large trend respectively. Alertness levels in sundowners are inconsistent when comparing time points, which may be representative of inconsistent attrition rates from participants due to willingness to participate, illness, and death.

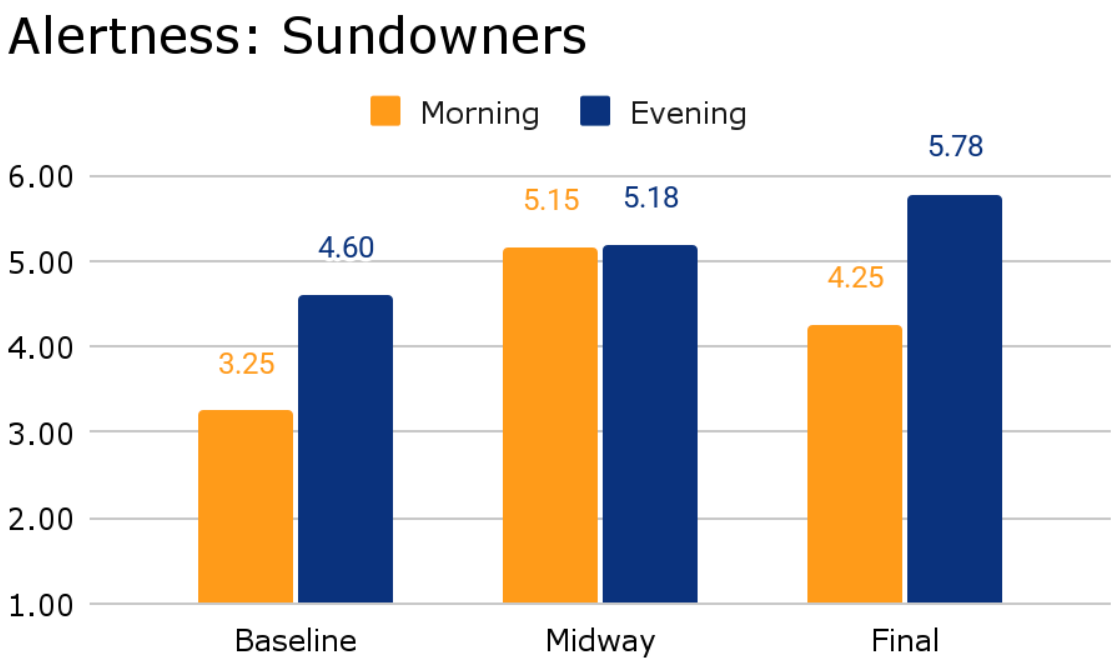

Figure 9. *Morning and Evening Alertness Scores for Sundowners*. The Observed Emotion Rating Scale was used to quantify resident alertness based on exhibited behaviors. The numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of increasing alertness throughout the study.

Non-sundowners showed a more predictable trend of general alertness after the RCP introduction. As expected, non-sundowners have similar levels and low discrepancies between alertness during the morning and evening. Figure 10 shows levels of general alertness in sundowners, demonstrating a -0.33, 0.50, and 0-point discrepancy between morning and evening agitation levels during the three data points. Furthermore, there is an expected trend of increasing overall alertness. For non-sundowners, there was a longitudinal increase in general alertness, with a 1.33-point increase for morning alertness and a 1.66-point increase for evening alertness. The effect size for non-sundowner alertness increase is 1.63 for the morning and 4.37 in the

evening, representing another strong elevation. Data for non-sundowners is consistent with the hypothesis that the RCP decreases discrepancy and increases overall alertness levels.

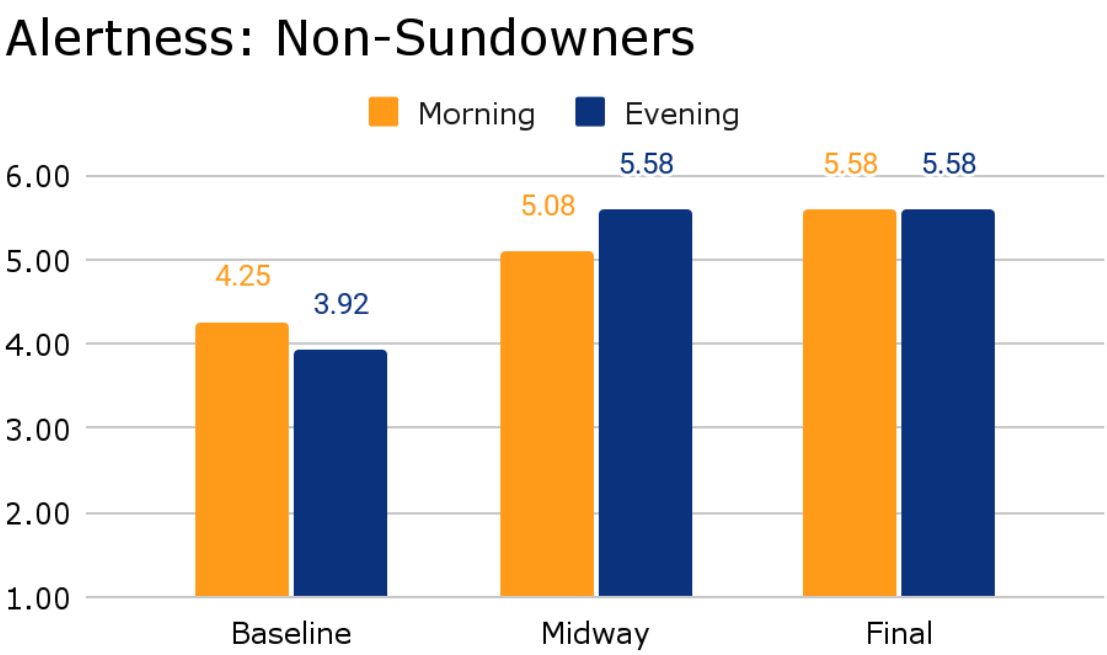

Figure 10. *Morning and Evening Alertness Scores for Non-Sundowners*. The Observed Emotion Rating Scale was used to quantify resident alertness based on exhibited behaviors. The numbers are an average of participant scores in the morning and evening during baseline, midway, and final observations. There is a trend of increasing alertness throughout the study, with a slight plateau.

Results: Qualitative

Variability of Resident Interactions

Just as the expressions of AD and the presence of SS among patients are variable, so is their response to the RCP. As noted by the staff at Fox Trail, their responsiveness "depends on [an individual's] temperament and progression," and that it would help more "depending on the resident." Through qualitative observations, it is apparent that high-functioning and

low-functioning residents would interact with the RCP in different ways. High-functioning residents who were earlier in their AD progression tended to refuse the RCP more often, interacting with it more physically than interpersonally compared to low-functioning residents.

The three high-functioning residents seemingly interacted with the companion pet on a surface level. Staff noted that "a real animal would have been better" for one of these residents in particular, observing that she was only seen stroking the RCP rather than talking to it like some of the more low-functioning residents. For this resident, the RCP was not as effective. She did not seem to be as engaged, and her symptoms mainly pertained to restlessness rather than aggression. Another high-functioning resident also did not seem interested in communicating with the RCP, however, she was thrilled with the tactile sensations and brushed it with a comb, often bringing the RCP to the observers, saying "look how pretty she is now." Similarly, she was another resident who suffered from restlessness. For these residents, the calming effects of the RCP were derived from tactile sensations and having something to do with their hands, rather than from aspects of connection.

Interestingly, the third high-functioning resident was only interested in the RCP when other residents had one at the same time. While it was evident that she did not receive noticeable benefits from interacting with the RCP on her own, she derived the most value from interacting with others who had an RCP, using it as a facilitation for connection rather than a supplementation. Even though the high-functioning residents all acknowledged that the RCP "wasn't real," they still showed signs of increased pleasure and alertness in addition to reduced agitation and negative emotions, even with a surface-level physical interaction with them.

Low-functioning residents seemed to have a more interpersonal, but complicated, relationship with the RCPs. One resident specifically formed an incredibly close relationship

with the RCP, talking to it as if it were her grandchild and bringing it to sleep with her, clearly as a supplement for connection. This resident would often call the RCP her “pretty baby” and “sweetheart,” acting incredibly maternal with phrases such as “I know, I know, it’s alright” when it would begin to make sounds. Even while this resident was occupied with her own RCP during her observation period, she would often go around the room collecting the abandoned RCPs from previous residents to show them love. This resident thought of the RCP as a real child, and derived her benefits from taking care of it and using it as a source of bonding.

Two other low-functioning residents who were similar in their AD progression shared commonalities with how they interacted with and derived benefits from the RCP. When handed one, these residents would infrequently talk to the RCP, but were incredibly intrigued by them. One of these residents would sit there for the entirety of the observation period, frantically petting the RCP with a large smile on her face, sometimes kissing it on the head. The other resident was equally engaged with its presence, oftentimes staring at it in front of her, sometimes quietly speaking in response to its sounds. During these observation periods, where this resident had access to the RCP, she was noticeably more engaged with her surroundings and with the other residents around her as a result. Comparing these observed increases in pleasure and alertness to how these two residents were acting during baseline observations, less time was spent sleeping all day in the common area.

One of the most extremely progressed residents showed the most complicated relationship with the RCP. Sometimes when handed the RCP, she would laugh loudly whenever it made sounds or movement and was thrilled with its presence. However, other times she would be extremely distressed with the RCP's presence, requesting that it be taken away immediately and that the helper and observers needed to “bring [the cat] back to its mother. During these

times, the interpersonal relationship formed with the RCP that was bringing this resident joy was replaced with the association that the RCP needed to be with someone it already had a relationship with, causing immense stress and anxiety.

One resident in particular was moderately-functioning at the beginning of the observation and began to rapidly decline throughout the study's duration. She generally seemed to be positively affected by the RCP, increasing levels of pleasure and alertness, even though negative emotions remained similar. However, it was difficult to determine whether her relationship with the RCP was interpersonal or surface level due to the fact that she was often sick and frequently sleeping, unable to be woken up during the majority of the mid-way and final observation periods.

Variability in Prolonged Exposure

In addition to residents having different means of interacting with the RCP, they also varied in levels of sustained entertainment. Specifically, high-functioning residents began to interact with the RCP less frequently the more times they were introduced to them. It was apparent that residents who retained more cognitive capabilities were more likely to become bored with the RCPs, meaning that fewer benefits were derived for specific residents over time.

Some residents would plateau in levels of pleasure and alertness increase and levels of agitation and negative emotion reduction. This trend is apparent in Figures 2 and 4 for agitation, Figures 5 and 6 for pleasure, and Figures 9 and 10 for alertness. Morning pleasure and alertness began to plateau for sundowners, while morning agitation, morning and evening pleasure, and evening alertness began to plateau for non-sundowners. This pleasure is likely attributed to repeated exposure, with many residents quoting that the RCPs were "for the girls that think it's

real." As the study progressed, sometimes the RCPs were handed back to the helper once boredom started to arise, saying, "I've seen that before."

Overall, there seems to be a trend where pleasure and alertness are more heavily impaired with prolonged usage of the RCPs, while agitation and negative emotions still continue to decline. There are exceptions to this trend, where two of the low-functioning residents never got bored with the RCP. This lack of boredom with continuous usage is reflected in observed frequency and intensity of pleasure, even with prolonged exposure.

Effects on Negative Emotions

There was a unanimous consensus from the staff that the RCPs were useful, specifically in negative emotion redirection and potentially dampening their onset. Members of the staff commented that the RCP "kept [the residents] occupied," provided them with "an activity to engage with," and gave them "something to love." RCPs were a source of "one-on-one attention" that residents received when the staff was too busy performing personal care duties to engage with them, providing a sense of companionship. For one resident who was enamored with the RCP, loving it "like her grandchild" was an effective tool for redirecting sadness and prevented her "from wandering or wanting to go home." The RCPs acting as a source of positive interaction and familiarity made it easier to avoid negative emotions by distracting the residents with something the staff knows will drown the anger, fear, and sadness with joy.

However, RCPs showed more variability in negative emotion mediation during the evening. Qualitative observations show that residents tended to be less irritable after the introduction of the RCP. Additionally, it was further noted that many of the residents were irritated at the same time during the evening and throughout baseline measurements. However, it was also observed that residents with the RCP during the evening did not become as irritated

compared to the rest of the residents without one. Furthermore, once a resident's observation was over during the evening and they no longer possessed an RCP, it was more likely they would become more agitated. It seemed as if the presence of the RCP acted as a deterrent for negative emotions throughout the night, with the positive benefits slowly diminishing as the night progressed. Particularly, this effect was more noticeable in sundowners and seemed to reduce the heightened emotions.

Alternatively, there was the reverse effect for the residents without the RCP during the evening. Observationally, it seemed as if RCPs increased agitation during the evening in residents who did not have an RCP in their possession. Approximately 2-4 observations would happen during a time, meaning there were always several out at once. It was noted that if the volume was on during the evening, nearby residents without an RCP would seemingly become extremely agitated by the sound. While it is likely that the residents could have been agitated by not being in possession of an RCP, it is more likely that the sounds emitted were the issue on account of the agitation diminishing once the volume was muted. Although it is clear through qualitative observations that RCPs can aid in emotional redirection, these results vary depending on whether or not a resident had one in their possession.

Effects on Social Interaction

In addition to RCPs increasing the frequency of pleasure and alertness in residents through a source of interpersonal connection, they also acted as a means to facilitate social interaction amongst each other. Many residents were observed to be more integrated and engaged with their peers with an RCP present, even if the other individual did not have one in their possession.

RCPs acted as a facilitation for social interaction between residents in several different ways. They would talk about the RCPs to each other while talking to the RCPs together. RCPs were frequently shown off to other residents who compared which one was softer or more vocal. They were frequently brushed and petted together. Interestingly, on occasions where one resident would decide they no longer wanted the RCP in the moment, they would give it to someone else who either did not have one or looked as if they wanted one.

Although the presence of RCPs allowed residents to bond with each other, social cohesion did not extend far beyond. As seen by the staff, after the RCPs were initially introduced, residents became increasingly possessive. Even though there were no territorial disputes over ownership of RCPs, residents became protective of items such as blankets and pillows. Even though RCPs were a source of facilitation for interaction, solidarity was not retained when it came to other material objects. The reason for this observation is inconclusive, however, it can be theorized that possessiveness emerged as a behavior as a result of how the study was conducted. Since RCPs were frequently passed between the residents and they were not retained after the twenty minute observation period, it could be the case that residents turned to hoarding other familiar belongings as a means to retain objects they believed they had a claim over since they were unable to keep the RCPs. This observation may show differences in presence or intensity of possessiveness depending on the length of RCP ownership.

Effects on Caregiver Stress and Burden

It was initially anticipated that the RCPs would inadvertently reduce caregiver stress and burden due to the associated decrease in agitation and negative emotions. However, this is not the case. During interviews with the staff, it was found that the presence of RCPs does not noticeably reduce caregiver burnout. The staff mention how the RCPs only provide aid if they

"don't have time" to "physically do an activity with [the residents]," using the RCP as "their activity of the day."

Staff explained how RCPs "don't take pressure off." There is an extreme staff shortage, and the majority are required to work double shifts to compensate. Without an activity director, "one person is left to do everything caretaking related- trash, laundry, cooking, etc" on top of keeping residents entertained and engaged. It is mentioned how "the ratio of patients to caregivers needs to be updated," and how a shortage in staff leads to a "high burnout rate" that could either be avoided with more workers throughout the day and a "competitive pay rate" to encourage people to enter this profession.

Discussion

The purpose of this observational study was to investigate the relationship between RCPs and expressed emotions and behavior for people with AD to see if they could be used as a viable NPT. It was expected that there would be differences in the discrepancy between morning and evening emotion and agitation levels when comparing sundowners and non-sundowners, with sundowners showing increased levels of agitation and negative emotions during the evening. With the RCP introduction, it was hypothesized that there would be decreases in agitation and negative emotions with increases in pleasure and alertness for both demographics, decreasing caregiver stress as a result. Furthermore, it was expected that there would be a decrease in the discrepancy in emotion and agitation levels between morning and evening observation periods after the conclusion of the study.

Baseline Findings and Interpretations

Overall levels of agitation were extremely low during baseline observations before RCP introduction. Miniscule levels could be due to there being only women present in the home, since

according to the staff, women with AD tend to display less aggressive behaviors compared to men with AD. However, after adjusting the CMAI, there is a more representative picture of agitation levels for sundowners and non-sundowners. Sundowners showed increasing levels of agitation during the evening, while non-sundowners showed decreasing (or equal) levels of agitation during the evening. 62.5% of the participants exhibited symptoms of SS. Although this is on the higher end, it is within the 2.4-66% SS prevalence rate range reported by Khachiyants et al. (2011) for all dementias, but it falls outside the 2.4-25% range of SS in AD. The high percentage is likely due to a small sample size, which would likely decrease with the presence of more participants.

Unexpectedly, even though sundowners' agitation increased during the evening, overall agitation during baseline for non-sundowners was almost double that of sundowners. This could be explained by looking at the agitation inventory items of the CMAI. While participants who sundown showed more aggressive behaviors, such as yelling, cursing, and grabbing, non-sundowners showed more passive behaviors to display their agitation, such as tapping, wandering, and disagreement. Even though sundowners show lower levels of agitation, when looking at the data, it is clear that they showed higher intensities of agitation less frequently, while non-sundowners showed less aggressive displays of agitation at a higher rate.

Although sundowners showed heightened levels of agitation during the evening during baseline observations, the discrepancy between morning and evening levels of pleasure was in the unexpected direction. Sundowners tended to show more pleasure during the evening, even though that is when they showed heightened levels of negative emotions and agitation. This is likely due to SS being the general heightening of emotions during the evening, not specifically towards agitation. Furthermore, lower levels of pleasure during baseline observations in

non-sundowners could be explained by being in close proximity to sundowners when they are displaying heightened levels of agitation, even though they themselves are not experiencing this phenomenon.

Negative emotions during baseline observations for sundowners were expected, with them being displayed almost twice as frequently. However, negative emotions for non-sundowners are also heightened in the evening to almost comparable levels to sundowners, even though they do not experience SS. Again, this is likely due to the proximity of non-sundowners to sundowners, with their mood and levels of agitation rubbing off on them.

Alertness levels for non-sundowners in baseline observations were similar between morning and evening periods. For sundowners, alertness was higher during the evening compared to the morning, surpassing levels of alertness seen in non-sundowners at any point during the day. Similar to the expected heightened agitation and negative emotions, in conjunction with the unexpected heightened pleasure during the evening, this trend of increasing general emotions in sundowners is consistent with alertness as well. Heightened alertness during the evening can either be explained by this general increase of every emotion, or it could be a result of heightened anxiety. During the evening, it could be the case that increased levels of anxiety lead residents to be more on edge, therefore, more aware of their surroundings.

RCP Findings and Interpretations

After introducing the RCPs, it was hypothesized that there would be a decrease in agitation, negative emotions, and caregiver stress with increases in pleasure and alertness. Agitation continued to decrease throughout the entire study for sundowners and non-sundowners, showing the effectiveness of the RCP as an NPT. In line with what was expected, there was both a total reduction and a reduction in the discrepancy between morning and evening levels of

agitation for sundowners. However, there was still a relatively large discrepancy between morning and evening agitation for non-sundowners after the study's conclusion. This could be linked to the previous finding that non-sundowners displayed less intensive behaviors more frequently, meaning that the RCP may be more effective for mediating intense displays of agitation rather than subtle signs of irritation. Regardless, the RPC showed value in reducing agitation, especially for sundowners during the evening.

Throughout the study, pleasure increased as expected for both demographics. However, there was a surprising direction in the discrepancy for sundowners, with pleasure being higher during the evening rather than levels being relatively similar regardless of time period. Again, this is likely due to the general heightening of emotions associated with SS. The RCPs also likely were effective in redirecting the negative emotions, leading to heightened levels of pleasure in response. Levels of pleasure for non-sundowners aligned with the hypothesis that it would increase pleasure and reduce the discrepancy in the expected direction. However, pleasure for non-sundowners did not increase to the same magnitude that it did for sundowners, showing the effectiveness of RCPs as an NPT for emotional mediation of SS.

Hypotheses were supported when looking at the reduction in frequency and discrepancy of negative emotions in both demographics to a similar degree. Throughout the entire study, negative emotions were extremely similar between sundowners and non-sundowners. Similarity between these expressions shows how the mood of sundowners can influence the mood of non-sundowners, showing why it is necessary to find suitable and effective treatments for emotional mediation. Furthermore, it shows the effectiveness of RCPs across both demographics relating to anger, anxiety or fear, and sadness.

For levels of alertness in sundowners, there was an increase in the total frequency shown; however, the discrepancy between morning and evening time periods remained present to a noticeable extent. It may be possible that alertness is higher for sundowners in the evening after RCP introduction because now attention is redirected to focusing on the RCP rather than the influence of increased anxiety. Focusing on the RCPs during the evening seemingly allows residents to have an outlet for their heightened emotions that are difficult to regulate. This is supported by the data, with increases in pleasure being relative to decreases in negative emotions, meaning that it is possible that increasing attention on the RCP acted as a distraction from feeling negative emotions, increasing pleasure due to a focus shift towards something positive rather than anxiety-inducing.

Alertness in non-sundowners aligned with the hypothesis where there was a predicted increase in total levels and a decrease in discrepancy, with there being equal levels during morning and evening time periods. While sundowners used the RCPs as a tool for mediation, equal levels and reduced discrepancy in non-sundowners could be due to them using the RCP as an outlet for enjoyment during both times of the day since they were not experiencing the emotional turmoil at night associated with SS. However, equal levels of alertness in non-sundowners could be additionally attributed to an observed higher level of general functioning.

Regarding caregivers' perspectives, the RCPs were not effective in reducing stress and burden. When interviewing caretakers after observation periods, it was clear that while RCPs were useful in redirecting the resident’s negative emotions, they did not directly impact the ease of their jobs. For instance, staff quoted other implementations necessary for reducing their stress, such as a higher salary, more staff, and an activity director. Furthermore, staff commented that

there needed to be a better work-life balance to provide the best care for the residents. While RCPs were beneficial for the residents, it was not necessarily beneficial for the staff since they did not reduce their daily workload.

Additional Findings

Observers noted there to be a relationship between cognitive decline and the received benefit from the RCP. Potentially, it was observed that the RCP benefit acted as a normal distribution curve in relation to the level of functioning. For example, it was seen that residents with less cognitive decline, who were higher functioning, were not particularly interested in the RCP to the same extent as residents further along in their prognosis. It was also noted that higher functioning residents tended to fall into the non-sundowner category, while sundowners were primarily made up of lower-functioning residents. Residents who were of moderate cognitive functioning tended to be the most interested in the RCP, going back and forth between treating it as if it were alive and stating that they knew it was inanimate. Moderately-functioning residents additionally seemed to receive the most benefits from the NPT. Similar to high-functioning residents, participants with severe cognitive decline also did not seem to be interested in the RCP, even though this demographic believed it to be real. Generally, it seemed as though the RCP was most useful for residents with moderate cognitive functioning, with interest being highly variable when it came to the higher and lower-functioning individuals.

Limitations

It is necessary to note that there are several limitations to this study. First, there was an extremely small sample size that did not reach the requirement threshold to make this study statistically significant. Furthermore, data collection is not consistent among residents. Many of the residents have gaps in their data due to refusal to leave their rooms, refusal to accept an RCP

at the time, or refusal to wake up to participate in the observation. There is also inconsistent attrition with residents, where one resident in particular became ill and one passed away. Due to issues associated with doing studies on populations with dementia and AD, the majority of residents do not have a consistent longitudinal timeline, which may have impacted the final results.

Additionally, this was an observational longitudinal study, not a randomized controlled trial. This means that due to how the study was conducted, only correlations can be gathered from the data and effects of causation cannot be supported without further research. Due to this study further using a dosing approach to RCP distribution since there were not enough available for everyone to have their own, the study only focused on the acute effects of the RCP rather than the cumulative effects of their presence. If participants had their own RCP for the entire study length rather than in twenty-minute intervals, results may have varied.

More limitations arise in the form of barred access to information about this protected population. For instance, it was not possible to obtain information or data about medication usage or standardized cognitive functioning scores. Meaning, it cannot be verified whether RCPs led to a decreased use of sedatives, or if sedative administration increased and led to the observed effects. It would be important for future studies to obtain records of pharmacological medication administration while attempting to verify RCPs as an effective NPT for mood and behavioral disturbances to ensure that all variables are held consistent. Furthermore, we cannot verify the theory that there is a normal distribution curve relative to cognitive functioning to RCP interest and benefit.

Implications

Results from this study imply that RCPs are a viable tool for the treatment of agitation and negative emotions in populations with AD, with the added benefit of increased pleasure and alertness. Furthermore, they are particularly beneficial for people experiencing SS. However, more research in this field needs to be done. Specifically, there should be more randomized controlled trials of bigger sample sizes. Regardless, there are positive implications for reducing the cost of AD care and the financial burden that weighs on the economy and individual families. RCPs may be able to serve as a cheaper non-pharmacological alternative to expensive and unreliable pharmaceuticals.

Conclusion

Though analyzing the results obtained from this study, it is suggested that RCPs are a useful NPT for mediating the behavioral and emotional difficulties seen in patients with AD, especially if they experience the phenomenon of SS. RCPs showed trends of decreasing the total presence of agitation behaviors as well as the discrepancy of behaviors between the morning and evening. Furthermore, they showed a positive impact on observed emotions, increasing the presence of pleasure and alertness while simultaneously decreasing the frequency of negative emotions such as anger, anxiety or fear, and sadness.

It is believed that RCPs show promise in dementia care treatment. However, they are effective up to a certain point. More benefits would be derived by using RCPs in conjunction with other NPTs of pharmacological intervention as needed rather than as a stand-alone treatment. While RCPs were extremely beneficial for residents who possessed moderate cognitive functioning, high-functioning and low-functioning individuals may perhaps benefit more from a combination of specialized treatment more targeted to their level of cognitive capabilities.

Even though RCPs were beneficial for residents, they were not as useful for caretakers. While it was hypothesized that the presence of RCPs would decrease caregiver stress and burden through decreasing the frequency of resident agitation, it is observed that this stress does not disappear due to other straining factors associated with caretaking responsibilities.

Although future research in this field needs to expand the sample size and modify the type of study performed, RCPs demonstrate potential for patient intervention, with the ability to feasibly decrease the need for sedative and behavioral medications. This form of treatment may show promise in reducing the cost of AD care and can feasibly be a stepping stone for improving the quality of life for patients and families.

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Appendix

i) Cohen-Mansfield Agitation Inventory short form:

Rating	Behavior
	cursing/verbal aggression
	hitting, kicking, pushing, biting, scratching, aggressive spitting
	grabbing onto people, throwing things, tearing things, or destroying property
	other aggressive behaviors or self-abuse including: intentional falling, making verbal or physical sexual advances, eating/drinking/chewing inappropriate substances, hurt self or other
	pace, aimless wandering, trying to get to a different place (e.g. out of the room/ building)
	general restlessness, performing repetitious mannerisms, tapping, strange movements
	inappropriate dress or disrobing
	handling things inappropriately
	constant request for attention or help
	repetitive sentences, calls, questions, or words
	complaining, negativism, refusal to follow directions
	strange noises (weird laughter or crying)
	hiding things, hoarding things
	screaming

The modified CMAI short form used a scale of 1-5 rather than 1-4 using the following criteria to show the frequency of occurrence:

1: Never Seen
2: Infrequent
3: Sometimes
4: Frequently
5: All the time

ii) Observed Emotion Rating Scale

PLEASURE Signs: Laughing; singing; smiling; kissing; stroking or gently touching other; reaching out warmly to other; responding to music (**only** counts as pleasure if in combination with another sign).							
ANGER Signs: Physical aggression; yelling; cursing; berating; shaking fist; drawing eyebrows together; clenching teeth; pursing lips; narrowing eyes; making distancing gesture.							
ANXIETY/FEAR Signs: Shrieking; repetitive calling out; restlessness; wincing/grimacing; repeated or agitated movement; line between eyebrows; lines across forehead; hand wringing; tremor; leg jiggling; rapid breathing; eyes wide; tight facial muscles.							
SADNESS Signs: Crying; frowning; eyes drooping; moaning; sighing; head in hand; eyes/head turned down and face expressionless (**only** counts as sadness if paired with another sign).							
GENERAL ALERTNESS Signs: Participating in a task; maintaining eye contact; eyes following object or person; looking around room; responding by moving or saying something; turning body or moving toward person or object.							

The above OERS was modified from a scale of 1-5 (+7) to 1-6 (+7) using the following criteria to quantity emotions based on behavior:

1: Never
2: Less than 16 seconds
3: 16-59 seconds
4: 1-5 minutes
5: 5-10 minutes
6: 10-20 minutes
(7: Not in view)

Furthermore, the OERS was modified from a ten-minute time frame to a twenty-minute time frame to maintain consistency with the CMAI observational period.