The effects of virtual reality and video conferencing on personal and relational well-being among older adults with cognitive impairments and their adult children: The Thrive randomized controlled trial

Trial Registration:[1] ClinicalTrials.gov NCT05150990

Supplementary Appendix

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[1] Registration of this social-behavioral trial was completed in accordance with the NIH Policy on Dissemination of NIH-Funded Clinical Trial Information. Trial registration was submitted to ClinicalTrials.gov on October 28, 2021 and posted publicly on December 9, 2021.

A. Recruitment and Consent Procedures

Recruitment and Consent: Older adults with mild to moderate cognitive impairment were recruited from 23 senior living communities in two geographic regions in the United States (Santa Barbara, CA, and Boston, MA, and surrounding areas) and were invited to nominate one adult child to participate with them. Approximately half of the communities were in California; five were low-income housing communities. The trial (including outreach, recruitment, intervention, and all follow-up assessments) was conducted between September 1, 2021 and March 16, 2024. The first dyad was enrolled October 2, 2021, and enrollment was closed December 1, 2023.

Recruitment activities occurred in several stages and were coordinated with directors at each participating senior living community (SLC). First, the director created a list of all potentially eligible residents who may qualify for the study. Directors and researchers also announced the study to residents via emails, flyers, town halls, and social gatherings. Additionally, a letter was mailed (through the SLC) to families of potentially eligible residents explaining the study, inviting them to participate, and allowing them to opt out of further contact.

Next, researchers spoke in person with potentially eligible residents to determine if they were interested and eligible to participate. At this time, researchers conducted a brief screening interview and administered the *Mini-Mental State Examination*, Version 2 (MMSE-2)[1], to verify eligibility [MMSE scores of 25–27 indicated mild cognitive impairment (MCI); scores of 13–24 indicated Alzheimer's disease or related dementias (AD/ADRD)]. If eligible, the resident was asked to provide contact information for one adult child who might be willing and able to participate with them in the study. If no adult child was available (approximately 5% of cases), the resident could nominate another family member who served in a caregiving role (most named a niece or nephew). If the resident had dementia or their capacity to provide informed consent was uncertain, the researcher completed an additional screener assessing their decision-making capacity to consent, and consent was sought from the resident's legal guardian. To further verify the presence of dementia, the legal guardian or an adult child also completed the *AD8 Dementia Screening Interview,*[2] an 8-item informant-based measure of cognitive impairment.

Adult children (or other family members) were then contacted by phone, screened for eligibility, and invited to participate. Dyads were enrolled in the trial only after both family members provided written (or digitally signed) informed consent. In addition, older adults with dementia were re-consented prior to each technology session to ensure ongoing assent and ethical participation. Consent forms are available on ClinicalTrials.gov (NCT05150990).

Eligibility Criteria: To be eligible for participation, older adults were required to be at least 50 years old, fluent in English or Spanish, and score between 13 and 27 on the MMSE-2, indicating mild cognitive impairment (MMSE scores of 25–27) or mild to moderate dementia (MMSE scores of 13–24). (Individuals with MMSE scores below 13 were excluded due to anticipated difficulties completing study surveys and potential safety concerns.) They also needed to have an adult child (or another family member serving in a similar caregiving role) who lived ≥ 45 minutes away by car and was willing and able to participate with them. Additionally, the parent–child relationship had to be free from significant negativity or abuse. Older adults were excluded if they had a history of severe vertigo, seizures, or dementia-related hallucinations, paranoia, or aggressive behavior; or if visual impairments prevented them from viewing content in virtual reality or video chat. In a small number of cases (*n*=10) the older adult did not have an eligible child but elected to participate with a close family member who served in a

similar caregiving role. Of these, 6 were a niece or nephew, 1 was a grandchild, and 3 were close family friends described by the older adult as "like a child."

Adult children (or other family members) were eligible if they were at least 18 years old, fluent in English or Spanish, and lived ≥ 45 minutes away from the parent's senior living community. Additionally, their relationship had to be free from significant negativity or abuse. Adult children (or other family members) were excluded if they had a history of severe vertigo or seizures, or if they were unable to complete online surveys or view virtual reality or video content due to visual impairments.

To increase the socioeconomic and ethnic diversity of our sample, we included five low-income senior housing communities in our recruitment plan, including one primarily Spanish-speaking site. We also trained bilingual, native-speaking research assistants to read surveys aloud and facilitate sessions, with at least two fluent researchers present at each session to ensure translation accuracy. Despite these outreach and translation efforts, only two Spanish-speaking older adults ultimately enrolled in the study, and completed surveys through Spanish translation. One completed the intervention, the other withdrew after baseline due to a family emergency unrelated to the study. The adult children in these dyads were fluent in English and chose to complete the English versions of the surveys.

Incentives: Older adults and their participating family members each received $150 for completing the study: $100 after the intervention phase and $50 following the three-month follow-up survey. Compensation was prorated for participants who withdrew early. These modest incentives were intended to express appreciation for participants' time without exerting undue influence.

B. Enrollment and Attrition

Overall, 1163 older adults and adult children were approached for study participation, of which 791 were excluded (375 not interested, 252 ineligible, 164 other). A total of 186 parent-child dyads (372 individuals, 32%) provided informed consent and were enrolled in the study. Dyads were randomized into virtual reality (n = 90) and video chat control (n = 96) groups (**Figure S1**).

Randomization and Masking: Dyads were randomized (1:1 ratio) to either the VR or VC group using stratified block randomization, with strata defined by participant cognitive status (MCI vs. ADRD) and study region (Boston vs. California) to ensure balanced allocation across arms. The random allocation sequence was generated prior to study initiation (via the *randomizeR* package in R) by a Principal Investigator at UCSB (N. Collins) who was not involved in direct participant recruitment or enrollment. Due to the nature of the behavioral intervention, participants and study staff delivering the sessions were not masked to group assignments.

Attrition: Participant retention was monitored throughout the study, and reasons for attrition were recorded. Attrition was categorized into the following predefined groups: (1) Withdrew consent (participants voluntarily discontinued for personal reasons, such as time burden or loss of interest); (2) Adverse events (participants discontinued due to health or safety reasons – physical or psychological – including withdrawal by the study investigator); (3) Health-related limitations unrelated to the intervention that prevented continued participation (e.g., hospitalization, fall, cancer treatment); (4) Protocol deviations or ineligibility identified post-randomization (e.g., undisclosed history of seizure); (5) Partner withdrawal, where the dyadic nature of the study required discontinuation when a study partner withdrew; (6) Death during the study period unrelated to the intervention; and (7) Lost to follow-up, where participants became unreachable and did not complete one or more follow-up assessments.

Because participation in the intervention required both members of the dyad, if one member withdrew before the intervention concluded, the entire dyad discontinued; however, after the intervention was completed, individual members could withdraw independently, allowing the other member to remain in the study for follow-up surveys. All health-related withdrawals and parental deaths were unrelated to the intervention. **Table A** summarizes participant retention and reasons for attrition. A total of 89% of the dyads completed the intervention, and 86% were retained through the 3-month follow-up. Total attrition at the Post-intervention Survey (primary endpoint): 11% (20 dyads + 2 individuals = 42 participants of 372 consented). Total attrition at 3-Month Follow-up Survey: 14% (20 dyads + 12 individuals = 52 participants of 372 consented).

Figure S1 - CONSORT flow Diagram

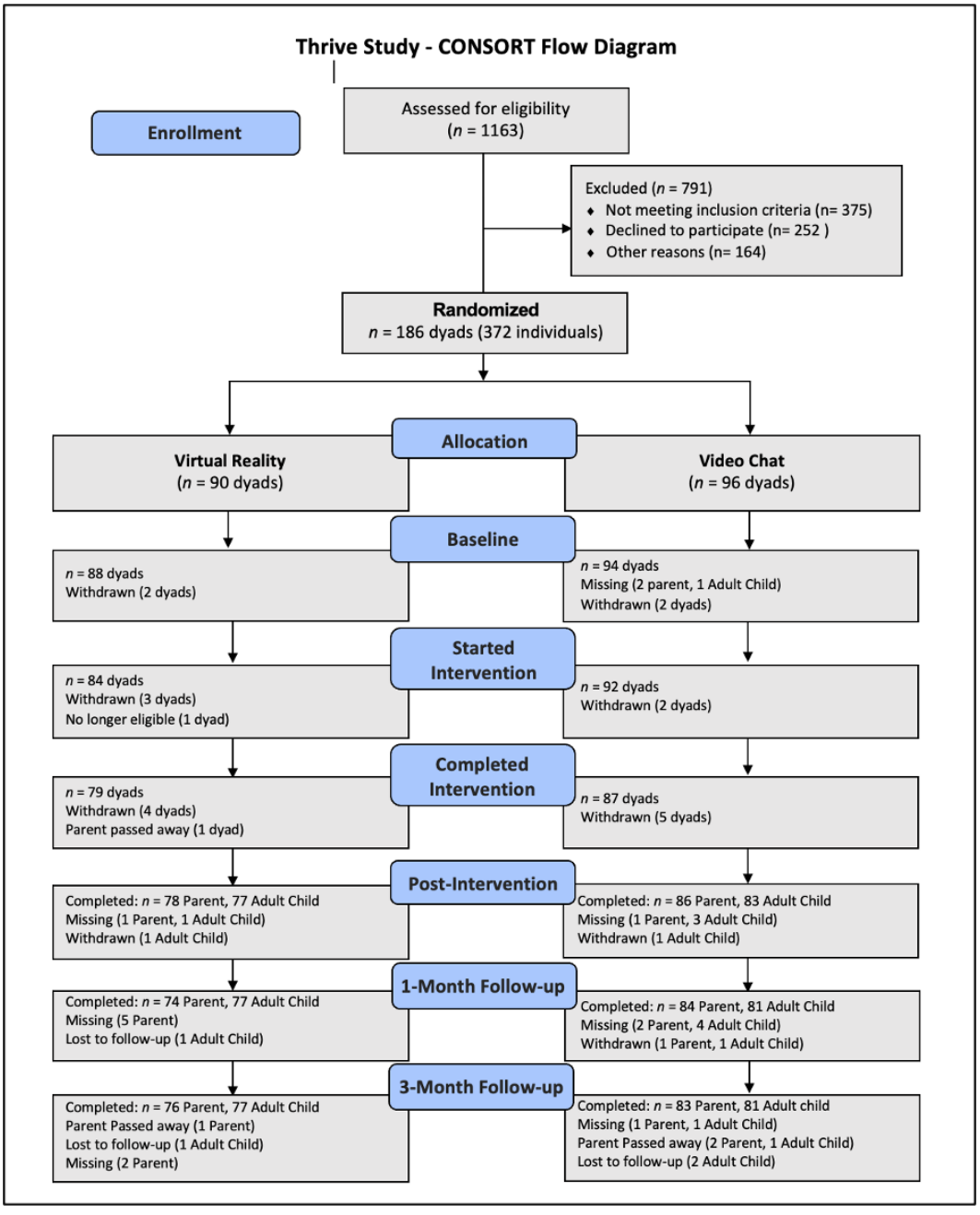


Table A: Thrive study summary of retention and reasons for attrition

Retention	Overall	Virtual Reality	Video Chat
Randomized	186 dyads	90 dyads	96 dyads
Baseline survey	182 dyads	88 dyads	94 dyads
Started intervention	176 dyads	84 dyads	92 dyads
Completed Intervention	166 dyads	79 dyads	87 dyads
Post-intervention survey (P/AC)[1]	166/164	79/78	87/86
1-month survey (P/AC)	165/163	79/78	86/85
3-month survey (P/AC)	164/161	78/77	84/84
Total Attrition	20 dyads + 12 individuals	11 dyads + 4 individuals	9 dyads + 8 individuals
Reasons for Attrition			
Change in health	7 dyads	2 dyads	5 dyads
Survey length/Time	4 dyads + 4 AC	1 dyad + 1 AC	3 dyads + 3 AC
External factors	2 dyads	2 dyads	0
Adverse response – family strain	2 dyads	2 dyads	0
Adverse response – discomfort	1 dyad	1 dyad	0
Passed Away	1 dyad + 3 P + 1A C	1 dyad + 1 P	2 P + 1 AC
Other	2 dyads	1 dyad	1 dyad
No longer eligible	1 dyad	1 dyad	0
Lost to follow-up	4 AC	2 AC	2 AC

Note: P = Parent, AC = Adult Child. [1] Because participation in the intervention required both members of the dyad, if one member chose to withdraw before the intervention concluded, the entire **dyad** was discontinued; however, after the intervention was completed, individual dyad members could withdraw independently, allowing the other member to remain in the study for follow-up surveys. This table does not include intermittent or administrative missing data (see the CONSORT diagram). All health-related withdrawals and parental deaths were unrelated to the intervention.

Missing Data: Participants who missed one or more survey assessments but later completed subsequent surveys were classified as *intermittent missing data*. These cases were retained in all analyses for which valid data were available. Reasons for missed assessments were not always reported but were most often due to time burden. In addition, in rare cases, survey data were lost due to administrative or technical errors despite participant completion; these are classified as *administrative missing data*. All missing data cases are listed in the CONSORT diagram (Figure S1).

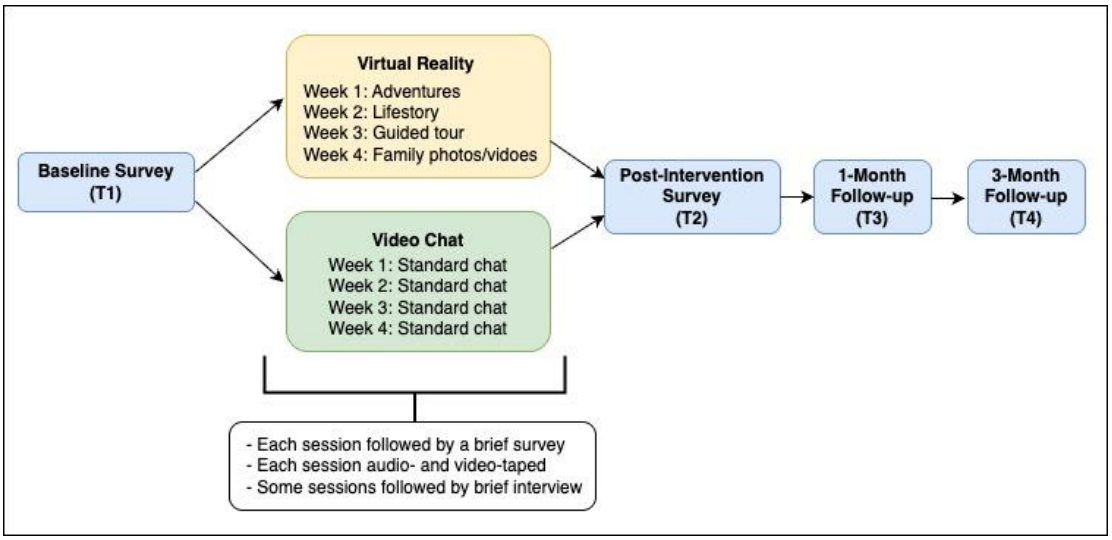
Adverse Events/Harms: Data on adverse events and potential harms were collected non-systematically through spontaneous participant self-reports and staff observation during scheduled study contacts. All adverse events were reviewed by Principal Investigators and an independent safety monitor to assess severity and potential relatedness to the intervention.

There were no serious or unexpected adverse events. However, three dyads in the VR condition discontinued due to discomfort related to the intervention. One older adult experienced physical discomfort while using the VR technology – she felt as though she was falling during the activity and had difficulty readjusting her vision afterward. Two families reported relational strain. In one case, the older adult expressed a preference for in-person (rather than remote) visits, which created tension within the family; the dyad discontinued in consultation with the research team. In the other case, the adult child felt hurt when the parent referred to the child's virtual avatar in disrespectful ways, which triggered unresolved emotional dynamics in their relationship.

C. Intervention Content and Procedures

Dyads enrolled in the Family Thriving and Technology Study (Thrive) participated in approximately six weeks of active engagement, followed by two post-intervention follow-ups at 1 and 3 months (see Figure S2). After enrollment, participants completed a brief intake survey assessing demographics and health conditions. Approximately one week before the intervention began, they completed a baseline survey (T1) assessing all primary outcomes. Dyads then participated in four weekly technology sessions (described below), each followed by a brief survey measuring secondary outcomes. Within one week of the final session, participants completed a post-intervention survey (T2), which served as the primary endpoint for the study and the basis for key hypotheses regarding change from baseline (T1). Two additional follow-up surveys at 1 month (T3) and 3 months (T4) reassessed all primary outcomes to evaluate the sustainability of any observed gains.

Figure S2 - Study timeline



T1-T4 Surveys: Older adults completed all surveys face-to-face. For those living with dementia, the researcher administered all surveys verbally and recorded the responses. For those with mild cognitive impairment, they were given the option to complete their surveys verbally or independently (via paper and pencil) with the researcher available to assist as needed. Adult children were emailed links to online Qualtrics surveys to complete on their own, with email and text reminders as needed.

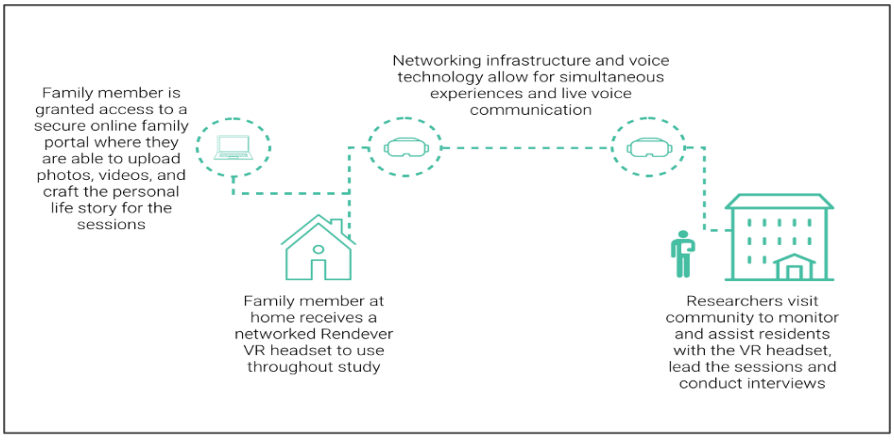
Technology Sessions: The intervention phase of the study consisted of four weekly technology sessions in which parents and their adult children participated together (see **Table B**). Parents participated in a private room at their senior living community (or their own room if needed), accompanied by researchers who assisted throughout the session. Adult children participated from their homes after receiving training from the research team. Each session lasted approximately 20 minutes (some were a little shorter if a participant was not feeling well or had other factors; some were a little longer if the participants were highly engaged and wanted to complete their activity).

Table B: Summary of intervention technology sessions

Study Group	Week 1	Week 2	Week 3	Week 4
Virtual Reality	Virtual Adventures	Virtual Travel Back in Time (Lifestory)	Virtual Guided Tour	Virtual Family Photos & Videos
Video Chat	Standard Video chat	Standard Video chat	Standard Video chat	Standard Video chat
Assessments (all groups)	Survey Audio and Video	Survey Audio and Video	Survey Audio and Video	Survey Audio and Video

Virtual Reality (VR) Sessions: Dyads assigned to the VR condition participated in four sessions using Rendever's VR platform, which is specifically designed for older adults. The sessions included: (1) virtual adventures, (2) virtual travel to one's childhood home and other meaningful past locations ("Lifestory"), (3) guided virtual tours, and (4) shared viewing of family photos and videos in VR. Parents were seated in a stationary chair throughout the session and were accompanied by two researchers who assisted with putting on the headset and operated the platform via a control tablet. Adult children participated from their own homes and were supported by the researcher who remained in phone contact during each session. Headsets, instructions, and training were provided to adult children approximately one week before the first session, including a remote orientation to the Rendever headset and platform via video conferencing. **Figure S3** illustrates how the Rendever platform operates to connect family members.

Figure S3 - How Rendever works with residents and family members



The VR headset used in the Thrive intervention was a Pico G2 4KE – a standalone VR headset with 3 degrees of freedom and dual LCD panels, with 3840 x 2160 resolution, and refresh rate of 75Hz, powered by a Qualcomm Snapdragon 835 processor and a custom Android-based OS. Each headset included a built-in microphone, and networked communication, which allowed for real-time audio interaction between parents and adult children during their VR sessions.

In VR Session 1 (**virtual adventures**), the dyad chose five immersive adventures (e.g., a safari, riding in a hot air balloon over Portugal, boat ride in Thailand) from more than 80 possible pre-programmed adventures. In Session 2 (**virtual Life Story**), research assistants took parents and their adult children back to eight favorite addresses or destinations from the parent's past (e.g., childhood homes, family vacation sites, schools they attended, where they were married). The adult child chose the addresses (with input from their parent) and entered the addresses into Rendever's password-protected, online

family portal. In Session 3 (**virtual guided tour**), the researcher took the dyad on a virtual guided tour through a global destination of their choosing (e.g., hiking Machu Picchu, tour of Rome). For Session 4 (**virtual photos and videos**), the adult children uploaded 15+ family photos and 1 to 2 videos with a simple "drag and drop" interface to Rendever's family portal. During this session, the parent and their adult child viewed the photos and videos together from a virtual family room in which they were seated together on a virtual sofa with personalized avatars.

Video Conferencing/Chat (VC) Sessions: Dyads assigned to the active control condition followed the same weekly schedule and completed the same surveys as those in the VR condition, but instead engaged in conversations via video chat using the Zoom platform. Unlike the VR sessions, no structured activities were provided; participants were simply encouraged to talk with each other as they normally would during a weekly conversation. For parents, the research team set up and operated the video chat sessions using laptop computers; adult children were sent an email link to each session. Once the session began, the research assistant stepped away to allow for privacy but remained within hearing distance to offer support if needed. Instructions and training were provided to adult children approximately one week before the first session, including a remote orientation to the Zoom platform.

Audio and Video Taping: With permission from participants, all technology sessions were audiotaped and parents (only) were also videotaped. Most participants (95% of parents and 90% of adult children) consented to audio and video recording, resulting in 372 hours of recorded sessions. Older adults were recorded with their full body in the frame to allow for later coding of social and physical engagement.

Post-session Surveys: After each VR or VC session, participants completed a brief survey assessing their thoughts and feelings about the session they just completed. Parents completed the survey either independently using paper and pencil or with assistance from a researcher. Adult children received a link to an online Qualtrics survey immediately following each session.

D. Primary Outcomes - Self-Report Measures

Demographic and health characteristics were collected at intake for parents (age, gender, race/ ethnicity, marital status, education, and chronic health conditions) and adult children (age, gender, race/ethnicity, marital status, employment status, and type of relationship to the resident).

Primary outcomes included multiple components of psychological well-being, psychological distress, social connectedness, and relationship quality, along with caregiver-specific variables (guilt, perceived stress) assessed only for adult children. Participants completed these measures at four time points: baseline, one-week post-intervention (the primary endpoint), and at one- and three-month follow-ups. To accommodate parents with cognitive impairments and minimize participant burden, we used abbreviated versions of established scales.

Table C summarizes the measures used. Reliability coefficients (Cronbach's alpha) are reported for the baseline assessment and are representative of internal consistency across other time points. For each measure, we indicate which member of the dyad completed it (**P** = Parent; **AC** = Adult Child).

Table C: Self-report measures of primary outcomes

Scales and Measures	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Quality of Life (13 items) - P 1. How would you rate your physical health? 2. How do you feel about your energy level? 3. How has your mood been lately? 4. How about your living situation? How do you feel about the place you live now? 5. How would you rate your memory? 6. How would you describe your family and relationships with family members? 7. How do you feel about your relationship with your spouse or the person you feel closest to? 8. How would you describe your current relationship with your friends? 9. How do you feel about yourself? What do you think about your whole self, and all the different things about you? 10. How do you feel about your ability to do things like chores around the house or other things you need to do? 11. How do you feel about your ability to do things for fun that you enjoy? 12. How do you feel about your current situation with money, your financial situation? 13. How would you describe your life as a whole? When you think about your life as a whole, everything together, how do you feel about your life? Source: *Quality of Life in Alzheimer's Disease* (QoL-AD) scale (Logsdon et al., 1999).[3]	1 - Poor 2 - Fair 3 - Good 4 - Excellent	.80	–
Positive Affectivity (6 items) - P/AC *During the past week…* Alert, Enthusiastic, Happy, Curious, Excited, Interested Source: *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988).[4]	1 - Not at all 2 - A little 3 - Moderately 4 - Quite a lot 5 - Extremely	.85	.82
Negative Affectivity (6 items) - P/AC Upset, Sad, Bored, Nervous, Irritable, Distressed Source: *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988).[4]	Same as above	.76	.69

Scales and Measures	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Geriatric Depression Scale (15 items) - P *Over the past week…* 1. Are you basically satisfied with your life? (R) 2. Have you dropped many of your activities and interests? 3. Do you feel that your life is empty? 4. Do you often get bored? 5. Are you in good spirits most of the time? (R) 6. Are you afraid that something bad is going to happen to you? 7. Do you feel happy most of the time? (R) 8. Do you feel helpless? 9. Do you prefer to stay at home, rather than going out and doing things? 10. Do you feel that you have more problems with memory than most? 11. Do you think it is wonderful to be alive now? (R) 12. Do you feel pretty worthless the way you are now? 13. Do you feel full of energy? (R) 14. Do you feel that your situation is hopeless? 15. Do you think that most people are better off than you are? Source: *Geriatric Depression Scale – Short Form* (GDS-SF; Sheikh & Yesavage, 1986).[5]	0 - No 1 - Yes	.75	–
Depression (CESD) (10 items) - AC *During the past week…* 1. I was bothered by things that usually don't bother me. 2. I had trouble keeping my mind on what I was doing. 3. I felt depressed. 4. I felt that everything I did was an effort. 5. I felt hopeful about the future. (R) 6. I felt fearful. 7. My sleep was restless. 8. I was happy. (R) 9. I felt lonely. 10. I could not get "going." Source: Center for Epidemiological Studies Depression Scale Revised Short Form (CESD-R-10; Andersen et al, 1994).[6]	0 - Rarely or none of the time (less than 1 day) 1 - Some or a little of the time (1 to 2 days) 2 - Occasionally or a moderate amount of time (3-4 days) 3 - Most or all of the time (5-7 days)	–	.79
Mental Health Index (5 items) - P/AC *How things are going for you this week…* 1. Have you been a very nervous person? 2. Have you felt so down in the dumps that nothing could cheer you up? 3. Have you felt calm and peaceful? (R) 4. Have you felt downhearted and blue? 5. Have you been a happy person? (R) Source: *Mental Health Inventory–5* (MHI-5; Ware & Sherbourne, 1992).[7]	1 - None of the time 2 - A little of the time 3 - Some of the time 4 - A good bit of the time 5 - Most of the time 6 - All of the time	.75	.76

Scales and Measures	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Thriving (11 items) - P/AC 1. My life has a clear sense of purpose. 2. I am optimistic about my future. 3. My life is going well. 4. What I do in life is valuable and worthwhile. 5. I can succeed if I put my mind to it. 6. I am achieving most of my goals. 7. In most activities I do, I feel energized. 8. There are people who appreciate me as a person. 9. I feel a sense of belonging in my community. 10. I try to learn something new every day. 11. Other people decide what I can and cannot do. (R) Source: The first nine items are from the *Brief Inventory of Thriving* and the last two (10th item adapted) are from the *Comprehensive Inventory of Thriving* (Su, Tay, & Diener, 2014).[8]	1 - Strongly disagree 2 - Disagree 3 - Neutral 4 - Agree 5 - Strongly agree	.85	.85
Lubben Social Network (6 items) - P 1. How many family members or relatives do you see or hear from at least once a month? 2. How many family members or relatives do you feel at ease with that you can talk about private matters? 3. How many family members or relatives do you feel close to such that you could call on them for help? 4. How many friends do you see or hear from at least once a month? 5. How many friends do you feel at ease with that you can talk about private matters? 6. How many friends do you feel close to such that you could call on them for help? Source: *Lubben Social Network Scale* (LSNS-6; Lubben et al., 2006).[9]	0 - None 1 - One 2 - Two 3 - Three or four 4 - Five to eight 5 - Nine or more	.85	–
Loneliness (4 items) - P *How you feel lately…* 1. How often do you feel that you lack companionship? 2. How often do you feel left out? 3. How often do you feel isolated from others? 4. How often do you feel lonely? Source: Adapted from the UCLA Loneliness Scale (Russel, 1996).[10] The first three items capture loneliness indirectly and comprise the 3-item Loneliness Scale (Hughes et al., 2004).[11] The 4th item assesses loneliness directly. This approach is informed by the U.K. Office of National Statistics 2018 guidance on the measurement of loneliness.[12]	1 - Never 2 - Rarely 3 - Sometimes 4 - Often	.78	–

Scales and Measures	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Social Connection (7 items) - P 1. How would you rate your feeling of connection to people in the world at large? 2. How would you rate your feeling of oneness with the world? 3. How do you feel about the level of companionship in your life? 4. How would you rate your satisfaction with your social network? 5. How would you rate your connection with other members of your community? 6. How enjoyable do you find participating in activities and/or group meetings with others? 7. How much do you enjoy making new friends? Source: Items written for this study.	-100 Most unpleasant experience +100 Most pleasant experience	.82	–
Social Connection (5 items) - AC 1. How would you rate your feeling of connection to people in the world at large? 2. How would you rate your feeling of oneness with the world? 3. How do you feel about the level of companionship in your life? 4. How would you rate your satisfaction with your social network? 5. How included do you feel in your social groups? Source: Items written for this study.	-100 Most unpleasant experience +100 Most pleasant experience	–	.86
Relationship Closeness (4 items) - P/AC 1. My relationship with my child/parent is close. 2. My child/parent and I disclose important personal things to each other. 3. My child/parent and I like to spend time together. 4. My child/parent and I have a strong connection. Source: Adapted from the *Unidimensional Relationship Closeness Scale* (Dibble et al., 2011).[13]	1 - Strongly disagree 2 - Disagree 3 - Somewhat disagree 4 - Neutral 5 - Somewhat agree 6 - Agree 7 - Strongly agree	.88	.90
Relationship Satisfaction (3 items) - P/AC 1. Overall, how happy are you with your relationship with your child/parent? 2. How rewarding is your relationship with your child/parent? 3. In general, how satisfied are you with your relationship with your child/parent? Source: Adapted from Huston et al. (1986)[14] and Funke & Rogge (2007)[15]	1 - Not at all 2 - A little 3 - Somewhat 4 - Very 5 - Almost completely 6 - Completely	.93	.96

Scales and Measures	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Communal Coping (3 items) - P/AC 1. My child/parent and I will always get through our stress together. 2. My child/parent and I are "in it together" when it comes to tackling life's challenges. 3. My child/parent and I are a team when it comes to managing stress. Source: Adapted from the *Communal Coping Scale*, Afifi et al. (2015).[16]	1 - Strongly disagree 2 - Disagree 3 - Neutral 4 - Agree 5 - Strongly Agree	.84	.91
Perceived Stress (4 items) - AC 1. How often did you feel that you were unable to control the important things in your life? 2. How often did you feel confident about your ability to handle your personal problems? (R) 3. How often did you feel that things were going your way? (R) 4. How often did you feel that difficulties were piling up so high that you could not overcome them? Source: *Perceived Stress Scale* (Cohen et al., 1983).[17]	1 - Never 2 - Almost Never 3 - Sometimes 4 - Fairly Often 5 - Very Often	–	.70
Caregiver Guilt (5 items) - AC 1. I worry about whether my parent is being cared for well enough. 2. I feel bad about my lack of patience with my parent. 3. I feel bad that I can't visit my parent more often. 4. I feel bad that I don't engage in more meaningful activities with my parent. 5. I feel bad that my parent and I don't engage in more meaningful conversations with each other. Source: The first two items are adapted from Wells' et al.'s (1990)[18] *Caregiver Guilt Scale*. The remaining items were written for this study.	1 - Not at all 2 - A little 3 - A moderate amount 4 - A lot 5 - Almost unbearably	–	.74

Notes: To reduce redundancy and the number of hypothesis tests, we computed composite indices for three key outcome variables – *psychological well-being, psychological distress,* and *relationship quality* – by standardizing and averaging several conceptually related and highly correlated measures. This approach improves statistical efficiency, enhances reliability by minimizing measurement error, and reduces the likelihood of Type I errors. Composite scores also provide a more holistic representation of the underlying constructs, which is particularly valuable when assessing outcomes among people with cognitive impairments, whose responses may be more variable across individual items or scales. Although we also had several indicators of social well-being for the parents (loneliness, social network support, social connection), these were not highly intercorrelated (r's ranging from |.26| to |.42|, Table S1), and were therefore *not* combined into a single index. For parents: ***Psychological well-being*** = *Quality of Life, Thriving,* and *Positive Affectivity* (α = .85 at baseline). ***Psychological distress*** = *Depression, Mental Health Index,* and *Negative Affectivity* (α = .81 at baseline). ***Relationship quality with child*** = *Relationship Closeness, Relationship Satisfaction,* and *Communal Coping* (α = .84 at baseline). For adult children: ***Psychological well-being*** was composed of *Thriving* and *Positive Affectivity* (*r* = .61, α = .75 at baseline). ***Psychological distress*** = *Depression, Mental Health Index,* and *Negative Affectivity* (α = .86 at baseline). ***Relationship quality with parent*** = *Relationship Closeness, Relationship Satisfaction,* and *Communal Coping* (α = .84 at baseline). To reduce the impact of outliers, select parent measures (Depression, Closeness, Satisfaction, Communal Coping) were winsorized prior to constructing composite variables.

E. Secondary Outcomes - Self-Report Measures of Remote Family Sessions

Participants completed self-report ratings of their experiences immediately following each VR or VC technology session. Composite scores were computed for each session and then averaged across the four intervention sessions. To evaluate reliability over time, Cronbach's alphas were calculated to represent the consistency across the sessions. Additionally, to assess internal consistency within specific time points, Cronbach's alphas were computed at each individual session. The minimum and maximum alpha values across these time points are reported in parentheses. Parents and adult children completed the identical set of items listed below in Table D.

Table D: Self-report measures of secondary outcomes

Composite Scales	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Positive Emotion (6 items) *During the ___ session, I felt…* Alert, Enthusiastic, Happy, Curious, Excited, Interested Source: *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988).[4]	1 - Not at all 2 - A little 3 - Moderately 4 - Quite a lot 5 - Extremely	.81 (.85 - .87)	.88 (.87 - .90)
Negative Emotion (6 items) Upset, Sad, Bored, Nervous, Irritable, Distressed Source: *Positive and Negative Affect Schedule* (PANAS; Watson, Clark, & Tellegen, 1988).[4]	Same as above	.52 (.54 - .74)	.74 (.64 - .78)
Relational Connection (6 items) *During our session…* **1. I was involved in our conversation** **2. I was interested in talking to my child/parent** **3. I felt close to my child/parent** 4. Our interaction was emotionally meaningful 5. Our interaction was smooth 6. Our conversation was supportive Source: Items in bold are from the *Relational Communication Topoi* scale (Burgoon & Hale, 1984).[19] The remaining items were written for this study, based on our Phase I feasibility study (Afifi et al., 2022).[20]	1 - Strongly disagree 2 - Disagree 3 - Neutral 4 - Agree 5 - Strongly Agree	.79 (.81 - .83)	.85 (.87 - .88)
Relational Strain (6 items) **1. My child/parent acted bored by our conversation** **2. My child/parent dominated the conversation** **3. My child/parent seemed tense while talking to me** 4. We got on each other's nerves 5. Our interaction was strained 6. I felt criticized	Same as above	.76 (.57 - .72)	.84 (.69 - .76)

Composite Scales	Response Scale	Cronbach's alpha Parent	Cronbach's alpha Adult Child
Source: Items in bold were adapted from the *Relational Communication Topoi* scale.[19] The remaining items written for this study, based on our Phase I feasibility study.[20]			
Learned Something New (1 item) We enjoyed learning something new together Source: Written for this study, based on our Phase I study.[20]	Same as above	.63	.83
Reminiscence (1 item) We enjoyed reminiscing about old times Source: Written for this study, based on our Phase I study.[20]	Same as above	.70	.77
Shared Special Times (2 items) 1. We shared special moments 2. I enjoyed sharing a special experience with my child/parent Source: Written for this study, based on our Phase I study.[20]	Same as above	.72 r's (.30 - .53) α's (.43 - .69)	.84 r's (.56 - .61) α's (.71 - .75)

F. Secondary Outcomes - Observational and Computer Coding of Remote Family Sessions

Observational Coding of Engagement

Conversational, emotional, and behavioral engagement during the technology sessions were coded based on videotaped verbal and nonverbal behavior. A total of 608 sessions were coded. Thirteen trained research assistants used adapted versions of two established scales to code four types of engagement: *conversational* and *reminiscence engagement* were coded for both the parent and adult child based on audio and video data; e*motional* and *kinesic engagement* were coded from parents' nonverbal behavior (coded from video recordings, which were only available for parents). Ratings were averaged across the four sessions and then overall composites were computed by averaging the four session indices together.

1. Conversational engagement for parent and adult child were coded using 19 items from Burgoon & Hale's (1984) *Relational Communication Topoi Scale*.[19] For the current report, we computed two subscales measuring *conversational engagement* and *conversational lead.* One additional item was written specifically for this study to measure the degree to which the parent and child shared positive ***reminiscences*** **from the past.** Table E shows items used for this report, and reliability coefficients.

Table E: Observationally-coded measures of conversational engagement - Parent and Adult Child

Relational Communication Scale (Burgoon & Hale, 1984)[19] - Observational coding of conversational engagement of parents and adult children based on audio recordings. Each dyad member was rated separately. **Instructions:** Rate the extent to which the older adult (or adult child) engaged in each behavior with their child (or parent) using the following scale: 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree), and 5 (strongly agree).	**Cronbach's alpha Parent**	**Cronbach's alpha Adult child**
Conversational Engagement (7 items) 1. The older adult/adult child was involved in the conversation**.** 2. The older adult/adult child seemed to desire further communication between them. 3. The older adult/adult child was interested in talking to their child/parent. 4. The older adult/adult child was willing to listen to their child/parent. 5. The older adult/adult child tried to move the conversation to a deeper level. 6. The older adult/adult child acted bored by their conversation. (reverse scored) **7. The older adult/adult child had a difficult time articulating his/her thoughts.** (reverse scored)	.92 (.89 - .90)	.91 (.89 - .92)
Conversational Lead (2 items) 1. The older adult/adult child dominated the conversation. 2. The older adult/adult child did more talking than listening.	.93 r's (.95 - .97) α's (.97 - .98)	.93 r's (94 - .97) α's (.97 - .99)
Reminiscence (1 item) **1. The older adult/adult child reminisced positive moments from the past with their child/parent.**	.82	.82

Note: The two items in bold were created by our research team and added specifically for the current clinical trial.

2. Emotional engagement for the parent was assessed with items adapted from Guerrero's (2005) coding system for nonverbal communication,[21] including *vocalics* (11 items; e.g., sounding content, warm excited, animated) and *facial expressions* around the mouth (5 items; e.g., smiling, laughing, conveying wonder). **Kinesic engagement for the parent** was coded using Guerrero's *kinesics* items (8 items; e.g., gestures, posture, body movement). For the current report, we computed three subscales measuring *positive emotional engagement, active emotional engagement,* and *kinesic engagement.* Table F below shows the specific items used and reliability coefficients.

Table F: Observationally-coded measures of emotional and kinesic engagement - Parent

Guerrero's (2005)[21] nonverbal coding system - Parents' facial, vocal, and kinesic expression was coded based on video recordings (video recordings were not collected for adult children). **Instructions:** Rate the extent to which the person you are coding engaged in each behavior, with greater numbers indicating more of that behavior. Based on your observation of the older adult's face (or vocalics, or body), the resident:	**Cronbach's alpha Parent**
Emotional Warmth (7 items) 1. Never smiled (1)…… (5) Smiled a lot 2. Was facially unpleasant (1)…… (5) Was facially pleasant 3. Conveyed negative affect (1)…… (5) Conveyed positive affect 4. Was unfriendly (1)…… (5) Was friendly 5. Sounded irritated (1)…… (5) Sounded content 6. Sounded unpleasant (1)…… (5) Sounded pleasant 7. Sounded cold (1)…… (5) Sounded warm	.91 (.94 - .95)
Emotional Vitality (6 items) **1. No sense of wonder (1)…… (5) Conveyed a sense of wonder** 2. Never laughed (1)…… (5) Laughed a lot 3. Sounded sad (1)…… (5) Sounded happy 4. Was dull (1)…… (5) Was full of life 5. Was not excited (1)…… (5) Was very excited 6. Was inexpressive (1)…… (5) Was animated	.93 (.86 - .90)
Kinesic Engagement (3 items) 1. Little gesturing (1)…… (5) A lot of gesturing 2. Very little trunk/limb movement (1)…… (5) A lot of trunk/limb movement 3. Little kinesic behavior (1)…… (5) A lot of kinesic expression	.88 (.70 - .78)

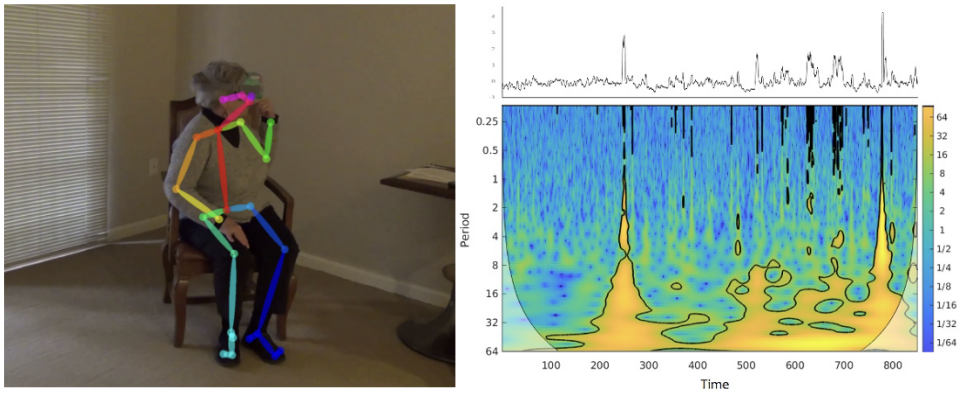
Note: The item in bold was written specifically for this clinical trial.

Automated Coding of Kinesic Engagement - Parent

In addition to human observational coding, parents' kinesic engagement during the remote family sessions was assessed using automated coding. As in our previous Phase I feasibility trial,[20] we analyzed parents' nonverbal behavior using *OpenPose*, an open-source software library developed by the Carnegie Mellon Perceptual Computing Lab for real-time 2D and 3D pose estimation.[22] OpenPose uses deep learning to detect and track 135 key points across the body, face, hands, and feet from video or images. This computer vision approach offers several advantages over traditional video-tracking methods, including greater robustness to background noise and variations in lighting. Figure S4 provides an illustration of this process.

In the current study, parents' full-body movements were recorded during their VR or VC sessions. Automated nonverbal analysis involved: (1) extracting movement time series from OpenPose 2D coordinates (targeting 10 key points including the eyes, nose, neck, shoulders, elbows, and hands/wrists); (2) standardizing the time series (M = 0, SD = 1); (3) applying a wavelet transform to the standardized data; and (4) calculating the proportion of wavelet power that exceeded red noise background levels. The resulting outcome variable was the proportion of time during which movement occurred in the 0.5–1.5 Hz frequency band. This frequency range reflects movement at approximately 1 Hz – about once per second – which is relatively fast and typically reflects active engagement during unstructured conversation. Values were averaged across the four remote family sessions to create a single index of kinesic engagement. Higher values indicate greater kinesic engagement.

Figure S4 - Example of automated coding using OpenPose



***Note*:** Automated coding of a Phase 1 resident (Afifi et al., 2021)[20] using *OpenPose*. The area where the wavelet power was significant against red noise backgrounds is surrounded by black lines. A period is an inverted value of the frequency band.

G. References

1. Folstein MF, Folstein SE, White T, Messer MA. *Mini-Mental State Examination, 2nd ed. (MMSE-2): User's Manual*. Lutz, FL: Psychological Assessment Resources; 2010.
2. Galvin JE, Roe CM, Powlishta KK, Coats MA, Muich SJ, Grant E, et al. The AD8: a brief informant interview to detect dementia. *Neurology*. 2005;65(4):559–64.
3. Logsdon RG, Gibbons LE, McCurry SM, Teri L. Assessing quality of life in older adults with cognitive impairment. *Psychosom Med*. 2002;64(3):510–9. doi:10.1097/00006842-200205000-00016
4. Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. *J Pers Soc Psychol*. 1988;54(6):1063–70.
5. Sheikh JI, Yesavage JA. Geriatric Depression Scale (GDS): Recent evidence and development of a shorter version. In: Brink TL, editor. *Clinical Gerontology: A Guide to Assessment and Intervention*. New York: The Haworth Press; 1986. p. 165–73.
6. Andersen EM, Malmgren JA, Carter WB, Patrick DL. Screening for depression in well older adults: Evaluation of a short form of the CES-D. *Am J Prev Med*. 1994;10:77–84.
7. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30(6):473–83.
8. Su R, Tay L, Diener E. The development and validation of Comprehensive Inventory of Thriving (CIT) and Brief Inventory of Thriving (BIT). *Appl Psychol Health Well Being*. 2014. doi:10.1111/aphw.12027
9. Lubben J, Blozik E, Gillmann G, Iliffe S, von Renteln Kruse W, Beck JC, et al. Performance of an abbreviated version of the Lubben Social Network Scale among three European community-dwelling older adult populations. Gerontologist. 2006;46(4):503–13. doi:10.1093/geront/46.4.503
10. Russell, D. W. (1996). UCLA Loneliness Scale (Version 3): Reliability, validity, and factor structure. *Journal of Personality Assessment, 66(1)*, 20-40.
11. Hughes ME, Waite LJ, Hawkley L, Cacioppo J. A short scale for measuring loneliness in large surveys: Results from two population-based studies. Res Aging. 2004;26:655–74. doi:10.1177/0164027504268574
12. Office for National Statistics. (2018, December 5). *National measurement of loneliness: 2018.* https://www.ons.gov.uk/peoplepopulationandcommunity/wellbeing/compendium/nationalmeasurementofloneliness/2018
13. Dibble JL, Levine TR, Park HS. The Unidimensional Relationship Closeness Scale (URCS): Reliability and validity evidence for a new measure of relationship closeness. *Psychol Assess*. 2011;24:565–72. doi:10.1037/a0026265
14. Huston TL, McHale SM, Crouter AC. When the honeymoon's over: Changes in the marriage relationship over the first year. In: Gilmour R, Duck S, editors. *The Emerging Field of Personal Relationships*. Hillsdale, NJ: Erlbaum; 1986. p. 109–32.
15. Funk, J.L., & Rogge, R.D. (2007). Testing the Ruler with Item Response Theory: Increasing Precision of Measurement for Relationship Satisfaction with the Couples Satisfaction Index. *Journal of Family Psychology, 21*, 572-583.
16. Afifi TD, Davis S, Merrill A, Coveleski S, Denes A, Afifi W. In the wake of the Great Recession: Economic uncertainty, communication, and biological stress responses in families. *Hum Commun Res*. 2015;41:268–302. doi:10.1111/hcre.12048
17. Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *J Health Soc Behav*. 1983;24:385.
18. Wells WD, Jordan JF, Jefroy R. Effects of care-givers on special day care programmes for dementia sufferers. *Aust N Z J Psychiatry*. 1990;24:82–90.
19. Burgoon JK, Hale JL. The fundamental topoi of relational communication. *Commun Monogr*. 1984;51(3):193–214. doi:10.1080/03637758409390195

20. Afifi T, Collins NL, Rand K, Fujiwara K, Mazur A, Otmar C, et al. Testing the feasibility of virtual reality with older adults with cognitive impairments and their family members who live at a distance. *Innov Aging*. 2021;5(2):igab014. doi:10.1093/geroni/igab014
21. Guerrero LK. Observer ratings of nonverbal involvement and immediacy. In: Manusov V, editor. *The Sourcebook of Nonverbal Measures: Going Beyond Words*. Mahwah, NJ: Lawrence Erlbaum; 2005. p. 221–35.
22. Cao Z, Hidalgo G, Simon T, Wei S-E, Sheikh Y. OpenPose: Realtime multi-person 2D pose estimation using part

Table S1: Correlations among parents' primary outcomes and covariates at baseline

Parents Primary Outcomes and Covariates	1	2	3	4	5	6	7	8	9
Primary outcomes									
1. Psychological well-being									
2. Psychological distress	-.65***								
3. Loneliness	-.50***	.61***							
4. Social network support	.36***	-.20**	-.26***						
5. Social connection	.57***	-.44***	-.42***	.37***					
6. Relationship quality with child	.41***	-.26***	-.30***	.31***	.32***				
Covariates									
7. Cognitive status (0=MCI, 1=ADRD)	-.26***	.08	-.03	-.27***	-.10	-.06			
8. Age	-.07	-.08	-.02	-.04	-.11	-.06	.17*		
9. Sex (0=M, 1=F)	.05	.06	-.04	-.02	.16*	-.03	-.01	.03	
10. Chronic health conditions	-.11	.16*	.08	.05	-.13+	.02	-.07	.02	.05

Note. N's range from 159 to 186. + $p < .10$, * $p < .05$, ** $p \leq .01$, *** $p \leq .001$.

Table S2: Correlations among adult children's primary outcomes and covariates at baseline

Adult Children Primary Outcomes and Covariates	1	2	3	4	5	6	7	8
Primary outcomes								
1. Psychological well-being								
2. Psychological distress	-.63***							
3. Perceived stress	-.57***	.72***						
4. Caregiver guilt	-.12	.24***	.22**					
5. Social connection	.65***	-.64***	-.46***	-.19*				
6. Relationship quality with parent	.16*	-.16*	-.10	-.09	.20**			
Covariates								
7. Parent's cognitive status (0=MCI, 1=ADRD)	-.01	.03	.06	.10	-.09	-.06		
8. Age	.05	-.11	-.14+	-.19*	.05	-.01	.14+	
9. Sex (0=M, 1=F)	.02	-.04	.01	.01	.10	-.01	.06	.01

Note. N's range from 179 to 186. + $p < .10$, * $p < .05$, ** $p \leq .01$, *** $p \leq .001$.

Table S3: Correlations among parents' secondary outcomes and covariates

Parents Secondary Outcomes and Covariates	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Self-reported engagement																	
1. Positive emotions																	
2. Negative emotions	-.42***																
3. Relational connection	.74***	-.29***															
4. Relational strain	-.50***	.46***	-.57***														
5. Learned something new	.51***	-.19*	.43***	-.27***													
6. Reminiscence	.35***	-.14+	.28***	-.25***	.36***												
7. Shared special moments	.63***	-.19*	.70***	-.46***	.56***	.58***											
Observational- and computer-coded engagement																	
8. Conversational engagement	.19*	-.13	.19*	-.26***	.01	-.01	.09										
9. Conversational lead	.17*	-.11	.22**	-.18*	.26***	.23**	.35***	.32***									
10. Reminiscence	.14+	-.10	.06	-.23**	.21**	.25***	.11**	.26***	.19*								
11. Positive emotional engagement	.28***	-.09	.26***	-.30***	.06	.06	.15+	.69***	.37***	.33***							
12. Active emotional engagement	.34***	-.21**	.28***	-.38***	.14+	.10	.19*	.68***	.34***	.45***	.85***						
13. Kinesic engagement (human-coded)	.29***	-.25**	.15+	-.24**	.16*	.09	.15+	.51***	.25***	.36***	.43***	.63***					

Parents Secondary Outcomes and Covariates	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
14. Kinesic engagement (computer-coded)	.01	-.08	-.02	-.09	.09	-.08	-.01	.05	.05	.09	-.03	-.003	-.04				
Covariates																	
15. Cognitive status (0=MCI, 1=ADRD)	-.16*	.04	-.09	.16*	-.11	-.07	-.07	-.18*	-.09	.05	-.15+	-.15+	-.20*	-.07			
16. Age	-.19*	-.01	-.11	-.02	-.06	-.04	-.10	-.09	-.06	.02	.03	-.03	-.24**	-.004	.17*		
17. Sex (0=M, 1=F)	.20**	.17*	.15*	-.08	.07	-.03	.14+	-.01	-.01	.08	.19*	.21**	.06	.003	-.01	.03	
18. Chronic health conditions	-.04	.13+	-.05	.06	.08	.08	-.04	.05	.09	.08	.07	-.02	-.09	.04	-.07	.02	.05

Note. N's range from 160 to 186. + $p < .10$, * $p < .05$, ** $p \leq .01$, *** $p \leq .001$.

Table S4: Correlations among adult children's secondary outcomes and covariates

Adult Children Secondary Outcomes and Covariates	1	2	3	4	5	6	7	8	9	10	11	12
Self-reported engagement												
1. Positive emotions												
2. Negative emotions	-.35***											
3. Relational connection	.71***	-.36***										
4. Relational strain	-.54***	.45***	-.63***									
5. Learned something new	.61***	-.20**	.51***	-.33***								
6. Reminiscence	.56***	-.17*	.46***	-.31***	.62***							
7. Shared special moments	.76***	-.24**	.82***	-.51***	.66***	.59***						
Observationally-coded engagement												
8. Conversational engagement	.02	-.04	.04	-.12	-.04	-.02	.02					
9. Conversational lead	.02	-.08	.15+	-.08	-.001	.02	.06	.13+				
10. Reminiscence	.07	-.11	-.05	-.05	.22**	.30***	.13+	.29***	.07			
Covariates												
11. Parent's cognitive status (0=MCI, 1=ADRD)	-.08	.14+	-.12	.08	-.15+	-.05	-.09	.01	.15+	.15+		
12. Age	.20**	-.03	.12	-.06	.14+	.07	.13+	.18*	.20*	.04	.14+	
13. Sex (0=M, 1=F)	.06	.11	.09	.03	-.07	-.08	.08	.12	.10	.002	.06	.01

Note. N's range from 162 to 186. + $p < .10$, * $p < .05$, ** $p \leq .01$, *** $p \leq .001$.

Table S5: **Changes in parents' primary outcomes from baseline to post-intervention (T1 to T2) in the overall sample and by technology condition and cognitive status**

Parents Primary Outcome Variables (Total / Sub-group)	Overall Sample	Technology Condition	
		Video Chat	Virtual Reality
	T2 - T1	T2 - T1	T2 - T1
Psychological well-being	.08+ (-.002, .16)	.04 (-.08, .15)	.12* (.003, .24)
MCI	-.03 (-.15, .09)	.03 (-.14, .19)	-.09 (-.26, .08)
ADRD	.19*** (.08, .31)	.05 (-.11, .21)	.34*** (.17, .50)
Psychological distress	-.10* (-.19, -.01)	-.10 (-.22, .03)	-.11 (-.24, .02)
MCI	-.09 (-.22, .04)	-.10 (-.28, .09)	-.09 (-.27, .10)
ADRD	-.11+ (-.24, .01)	-.10 (-.27, .07)	-.13 (-.31, .05)
Loneliness	-.03 [-.12, .05]	-.04 (-.16, .08)	-.03 (-.16, .10)
MCI	-.08 (-.21, .05)	-.08 (-.26, .09)	-.08 (-.26, .10)
ADRD	.01 (-.11, .13)	.01 (-.16, .18)	.02 (-.16, .19)
Social network[1]	.05 (-.07, .17)	.04 (-.13, .21)	.06 (-.12, .23)
MCI	-.10 (-.27, .08)	-.05 (-.29, .20)	-.14 (-.40, .11)
ADRD	.19* (.02, .36)	.13 (-.11, .36)	.26 (.02, .50)
Social connection[2]	4.26* (.68, 7.84)	2.76 (-2.23, 7.74)	5.76* (.61, 10.91]
MCI	5.09* (.02, 10.15)	7.46* (0.44, 14.49)	2.71 (-4.59, 10.01)
ADRD	3.43 (-1.64, 8.50)	-1.96 (-9.02, 5.11)	8.82* (1.55, 16.09)
Relationship quality with child	.14*** (.06, .23)	.14* (.02, .26)	.15* (.02, .27)

Parents Primary Outcome Variables (Total / Sub-group)	Overall Sample	Technology Condition	
		Video Chat	Virtual Reality
	T2 - T1	T2 - T1	T2 - T1
MCI	.12+ (-.004, .25)	.20* (.03, .38)	.04 (-.14, .22)
ADRD	.16** (.05, .28)	.07 (-.10, .24)	.26** (.09, .43)

Note. MCI = Mild cognitive impairment. ADRD = Alzheimer's disease and related dementias. Unless otherwise noted, n = 181. [1]n = 183. [2]n = 170. Values reflect estimated mean differences (95% CIs) from linear mixed models (Technology Condition × Cognitive Status × Time) controlling for age, sex, and chronic health conditions. Positive mean differences indicate increases in scores from T1 to T2 (baseline to one-week post-intervention); negative values indicate decreases. See Table 2 for full model results and Table 3 for difference-in-differences contrasts and corresponding effect sizes. + $p < .10$, * $p < .05$, ** $p \leq .01$, *** $p \leq .001$.

Table S6: Changes in parents' primary outcomes from baseline (T1) to all post-intervention assessments (T2 to T4) in the overall sample and by technology condition and cognitive status

Parents Primary Outcome Variables	Overall Sample			Technology Condition					
				Video Chat			Virtual Reality		
	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)
Psychological well-being	.08+ (-.01, .16)	.04 (-.06, .14)	.01 (-.10, .10)	.04 (-.08, .15)	.02 (-.12, .15)	-.02 (-.15, .12)	.12+ (.00, .24)	.07 (-.07, .21)	.03 (-.12, .17)
MCI	-.04 (-.15, .08)	-.04 (-.18, .10)	-.11 (-.25, .04)	.03 (-.14, .19)	.05 (-.14, .24)	-.08 (-.28, .12)	-.10 (-.27, .07)	-.13 (-.33, .07)	-.13 (-.34, .08)
ADRD	.19*** (.08, .30)	.12+ (-.01, .25)	.12+ (-.02, .25)	.05 (-.11, .20)	-.02 (-.20, .16)	.05 (-.14, .24)	.33*** (.17, .50)	.26** (.07, .45)	.18+ (-.02, .38)
Psychological distress	-.10* (-.19, -.004)	-.05 (-.16, .06)	.04 (-.08, .16)	-.09 (-.22, .04)	-.04 (-.20, .11)	.04 (-.13, .20)	-.10 (-.23, .03)	-.06 (-.22, .11)	.05 (-.12, .23)
MCI	-.08 (-.22, -.05)	-.10 (-.26, .06)	.02 (-.16, .19)	-.09 (-.28, .09)	-.05 (-.28, .17)	.11 (-.13, .34)	-.08 (-.27, .11)	-.15 (-.38, .09)	-.07 (-.32, .18)
ADRD	-.11+ [-.23, .02]	.001 (-.15, .16)	.07 (-.09, .24)	-.09 (-.27, .08)	-.03 (-.24, .18)	-.04 (-.26, .19)	-.12 (-.30, .06)	-.04 (-.19, .26)	.18 (-.06, .42)
Loneliness	-.03 (-.12, .06)	-.01 (-.11, .10)	.03 (-.08, .13)	-.03 (-.16, .10)	-.05 (-.19, .09)	.01 (-.13, .16)	-.03 (-.17, .10)	.04 (-.11, .19)	.04 (-.11, .19)

Parents Primary Outcome Variables	Overall Sample			Technology Condition					
				Video Chat			Virtual Reality		
	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)
MCI	-.08 (-.22, .05)	-.03 (-.18, .12)	-.01 (-.16, .14)	-.08 (-.27, .10)	-.12 (-.33, .08)	-.01 (-.21, .20)	-.08 (-.28, .11)	.07 (-.15, .28)	-.02 (-.24, .20)
ADRD	.02 (-.11, .15)	.02 (-.12, .16)	.06 (-.08, .21)	.03 (-.15, .20)	.02 (-.18, .22)	.03 (-.17, .23)	.02 (-.16, .21)	.02 (-.18, .23)	.10 (-.11, .31)
Social network support[1]	.04 (-.08, .16)	-.03 (-.15, .10)	.02 (-.11, .15)	.03 (-.14, .19)	-.16+ (-.33, .02)	-.05 (-.22, .13)	.05 (-.12, .22)	.10 (-.08, .29)	.09 (-.10, .28)
MCI	-.11 (-.28, .06)	-.07 (-.25, .11)	-.15 (-.33, .04)	-.06 (-.30, .18)	-.20 (-.45, .06)	-.20 (-.46, .06)	-.16 (-.41, .09)	.05 (-.21, .32)	-.09 (-.36, .18)
ADRD	.19* (.02, .35)	.02 (-.16, .19)	.19* (.01, .37)	.11 (-.12, .34)	-.12 (-.36, .12)	.11 (-.14, .35)	-.27* (.03, .50)	.15 (-.10, .41)	.27* (.01, .53)
Social connection[2]	4.29* (0.86, 7.71)	2.59 (-1.24, 6.41)	4.03* (0.07, 8.00)	2.85 (-1.92, 7.63)	0.98 (-4.39, 6.36)	3.21 (-2.29, 8.71)	5.72* (0.80, 10.64)	4.19 (-1.26, 9.64)	4.86+ (-0.86, 10.58)
MCI	5.30* (0.45, 10.14)	3.09 (-2.29, 8.47)	1.94 (-3.63, 7.51)	7.40* (0.66, 14.13)	3.93 (-3.58, 11.43)	3.43 (-4.34, 11.20)	3.20 (-3.78, 10.17)	2.25 (-5.45, 9.96)	0.45 (-7.53, 8.43)
ADRD	3.28 (-1.57, 8.12)	2.08 (-3.37, 7.53)	6.12* (0.47, 11.77)	-1.69 (-8.46, 5.09)	-1.96 (-9.65, 5.73)	2.98 (-4.80, 10.76)	8.24* (1.38, 15.18)	6.13 (-1.59, 13.84)	9.27* (1.07, 17.46)

Parents Primary Outcome Variables	Overall Sample			Technology Condition					
				Video Chat			Virtual Reality		
	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)	Baseline to Post-Interv (T2 - T1)	Baseline to 1-Month (T3 - T1)	Baseline to 3-Month (T4 - T1)
Relationship quality with child	.13*** (.05, .21)	.09* (.01, .18)	.07 (-.02, .16)	.13* (.02, .24)	.09 (-.03, .21)	.09 (-.03, .22)	.13* (.02, .25)	.09 (-.04, .22)	.05 (-.08, .18)
MCI	.12* (.001, .23)	.13* (.001, .25)	.09 (-.04, .22)	.20* (.04, .36)	.27** (.09, .44)	.18* (.003, .35)	.03 (-.13, .20)	-.02 (-.20, .17)	-.002 (-.19, .18)
ADRD	.15** (.04, .26)	.06 (-.06, .18)	.06 (-.07, .18)	.07 (-.09, .22)	-.08 (-.25, .09)	.01 (-.16, .18)	.23** (.07, .40)	.20* (.02, .37)	.10 (-.08, .28)

Note. MCI = Mild cognitive impairment. ADRD = Alzheimer's disease and related dementias. Unless otherwise noted, n = 181. [1]n = 183. [2]n = 172. Values reflect estimated mean differences (95% CIs) from baseline based on linear mixed models (Technology Condition ✕ Cognitive Status ✕ Time) with random intercepts, controlling for age, sex, and chronic health conditions. Positive differences indicate increases in scores from baseline; negative values indicate decreases. See Extended Data Tables 1 and 2 for full model results and difference-in-differences contrasts with corresponding effect sizes. + p < .10, * p < .05, ** p ≤ .01, *** p ≤ .001.