**Using mobile technology to provide personalised reminiscence for people living with dementia and their carers: An appraisal of outcomes from a quasi-experimental study**

*“I and my co-authors have approved the authorship information as rendered on http://mental.jmir.org/front/pdf/9684/1”*

Abstract

**Background:** Dementia is an international research priority. Reminiscence is an intervention that prompts memories, and has been widely used as a therapeutic approach for people living with dementia. A novel iPad app was developed to support home-based personalised reminiscence. It is crucial that technology-enabled reminiscence interventions are appraised.

**Objective:** This study sought to measure the effect of technology-enabled reminiscence on mutuality (defined as the level of ‘closeness’ between an adult living with dementia and their carer), quality of carer and patient relationship and subjective wellbeing.

**Methods:** A 19-week personalised reminiscence intervention facilitated by a programme of training and a bespoke iPad app was delivered to people living with dementia and their family carers, in their own homes. Participants (n=60) were recruited in dyads from a cognitive rehabilitation team affiliated with a large UK health care organisation. Each dyad comprised a person living with early to moderate dementia and his/her family carer. Outcome measurement data were collected at baseline, midpoint and intervention close.

**Results:** Participants living with dementia attained statistically significant increases in mutuality (p < .001), quality of carer and patient relationship (p < .001), and subjective wellbeing (p < .001) from baseline to endpoint. Carers attained non-significant increases in mutuality and quality of carer and patient relationship, and a non-significant decrease in subjective wellbeing.

**Conclusions:** Our results indicate that individual specific reminiscence supported by an iPad app may have efficacy in the context of early to moderate dementia. A robust randomised controlled trial of technology enabled personalised reminiscence is warranted.

**Keywords:** dementia, evaluation, mobile apps, reminiscence, research, technology

## Introduction

Dementia is an umbrella term that encompasses at least 40 conditions that feature progressive cognitive decline and are more prevalent in older age. In tandem with international ageing demographics, the prevalence of dementia and associated costs have risen substantially. The estimated annual UK cost of dementia is over £26 billion [1], and this is higher than the combined costs for cancer, stroke and heart disease. There is increasing evidence that non-pharmacological interventions for the symptoms of dementia can have commensurate effectiveness to pharmacological treatment and may be preferable where medication can cause negative side-effects [2-4]. The progressive nature of dementia presents a challenge for families providing care to a relative with this condition [5-7]. Not surprisingly, the World Health Organisation has prioritised dementia as a global public health concern, and has recommended that more research is undertaken to inform supportive interventions for people living with dementia and their families [8].

Reminiscence refers to a range of psychosocial interventions that prompt memories, and has been widely used as a therapeutic approach for people living with dementia and their carers [9,10]. Technology based reminiscence increases opportunities to participate in conversations and enhance their social interactions [10], and enables remote reminiscence, to be delivered in the home [11]. Traditional reminiscence utilises collections of resources, such as memory boxes that can stimulate a range of senses, including touch, taste and smell. In contrast, technology based reminiscence is reliant on visual and auditory memory prompts. These limitations may be offset by the portability, mobility and utility of technology based reminiscence systems to deliver personalised reminiscence experiences.

A systematic review [12] of technology supported reminiscence therapy identified 44 papers that met selection criteria. Although limited by the small sample sizes of some of the studies, the authors concluded that there were benefits to using ICT for reminiscence interventions. These benefits include access to rich and engaging multimedia reminiscence materials [13. 14], opportunities for people with dementia to participate in social interactions and take ownership of conversations [15,16] and a reduction in motor deficit related barriers when interacting with media [16, 17]. Ten papers reviewed [12] reported on the use of “reminiscence kits” that featured a technological component. Audio was a major component of these reminiscence kits, but impact evaluation was not reported. One study [17] had examined the attitudes of older people (n=19) to using an iPad to aid reminiscence. Participants in the study were randomly allocated to reminisce using either an iPad or more traditional images and cards. The results from that study indicated that participants enjoyed using the iPad. In a follow-up mixed methods design, a mobile device application ‘Memory Matters’(MM) was developed to promote reminiscence [15]. Eighteen people living with dementia and eight family carers were asked to use MM for a period of four weeks. Consistent with the findings of a more recent study that explored a similar device [18], the technology supported reminiscence was favourably evaluated. Family carers had enjoyed discussing the early years with their relative and on several occasions the people living with dementia shared memories in a direct response to prompts provided by MM. People living with dementia who had only interacted minimally, or who had never spoken before, were observed to interact and support each other while playing the application. These findings support the social engagement potential of mobile devices in the context of family care giving in dementia [19, 20].

As dementia progresses, it is common for carers to report a ‘disappearance of the relationship’ [21, 22]. There is a need to support care-giving relationships in order to protect mental and physical wellbeing [23, 24]. ICT has an important role in this endeavour, by supporting social connectivity [25]. It is important therefore that in studies of technology based reminiscence that family carers are included, in addition to persons living with dementia.

The research team was motivated by the rising acceptability of health apps to develop and test the feasibility of a novel app to deliver personalised reminiscence among people living with dementia and their carers. Consistent with recommendations [12], validated and standard outcome measures were selected for the appraisal of efficacy. Mutuality is a scale that measures closeness in a relationship [26], WHO-5 is a short scale for measuring emotional wellbeing [27] and Quality of Carer-Patient Relationship (QCPR) is a scale of family care-giving [28]. All three have been tested in dementia research, but not in reminiscence research. This paper contributes to the evidence base by reporting preliminary efficacy of technology based personalised reminiscence facilitated by a programme of training and an iPad app on mutuality, quality of care-giving relationships and subjective wellbeing among people living with dementia and their family carers.

## Development of a Reminiscence App

The size, capacity and low cost of ubiquitous devices and mobile tablet computers have made them an attractive option for technology based reminiscence systems. As part of this study, a cross-platform device agnostic tablet application (called InspireD: an acronym for **In**dividual **Sp**ec**i**fic **Re**miniscence for People living with **D**ementia) was developed to facilitate reminiscing activity. The two primary aims of the app were to enable people living with dementia and their family carers to select and store personalised memorabilia (photographs, videos, sounds, music) and to provide easy access to these visual and audio-visual cues to support bespoke reminiscence.

The InspireD app was developed [29] with input from the Reminiscence Network Northern Ireland and a user development group that comprised a total of 7 dyads, with each dyad comprising a person with dementia and their primary caregiver (n=14). The Agile software development approach [30] was adopted to allow the functional prototype to be created early in the development lifecycle, with testing for usability and refinement taking place throughout the development process [29]. The app was implemented using appcelerator studio, an Eclipse-based IDE that provides an environment to build, test, package, and publish apps for various platforms, including iOS and Android. The code is written in Javascript with native User Interface (UI) elements being invoked at runtime. It incorporates local facilities for persistent data storage in SQLite database and facilitates the use of third party Application Programming Interfaces (API) for Flickr and YouTube (Figure 1).

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**Figure 1.** InspireD App system architecture

The app consists of a user interface that is usable and responsive across a variety of mobile devices (tablets, mobile phones). It is also possible to use the system on a PC or laptop via the web browser. The main user (and co-users, i.e. carers) can upload images, videos clips and audio clips to the app. SQLite database functionality is used to store and manage data natively. The main user interface consists of a simple screen for people living with dementia to upload files with help from a reminiscence trainer or a family caregiver. A multi-screen layout allows users to choose which memorabilia they wish to access (fig 2a); view photos (fig 2b); watch videos (fig 2c); or listen to audio files (fig 2d); and browse selected resources.

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**Figure 2.** The InspireD reminiscence app user interface.

The design is minimalist, using verbal descriptors as well as images and icons to reinforce and indicate functionality to the user. Data are organised and presented primarily in the form of on-screen menus. The welcome screen is a simple login screen where the user confirms their identity by clicking a photo of themselves. The user data is contained within a local SQLite database, which can be easily queried with reporting services enabled. Multimedia reminiscing resources (photos, videos, audios) are also stored locally in the app data directory. The InspireD app incorporated a logging facility for five canonical events. These were Entry (logging in), Admin (adding a photo, deleting an audio, etc.). Reminiscing (viewing a video, viewing a photo, etc.), Ecological Momentary Assessment (EMA) questions and Exit (logging out). Usage data across the course of the intervention was collected via secure email, statistically analysed and the findings have been published [31]. EMA is influenced by Kurt Lewin [32]. The use of ‘in the moment’ approaches along with rigorous measurement techniques in psychometric research, has been validated in recent research [33-36]. In our study, EMA involved the delivery of a small series of five questions directly to participants through the app, and the feasibility of this approach in the context of dementia care is being appraised and will be reported in a subsequent paper. The InspireD system was designed with scalability in mind for future enhancements as it is envisaged that the final version will be a secure, cloud-based application, and accessible via a secure Internet connection for authorised users. Whilst the design incorporated the ability to store content locally on the device or to upload it to a cloud-based storage, a decision was taken by the team that for the feasibility study, all content would be stored locally on the device.

## Methods

This paper reports on a feasibility study that incorporated a quasi-experimental design. An intervention of home-based personalised reminiscence supported by a programme of training and a novel iPad app, was examined for preliminary efficacy using three outcome measures pertaining to mutuality, emotional wellbeing and quality of carer-patient relationships. The quasi-experimental design is appropriate, and a common design for assessing the feasibility of novel technological interventions [37-39]. In line with quality standards, repeated measures testing was employed. Data were collected at baseline, midpoint and intervention close. Table 1 outlines the intervention activities and data collection time-points.

The model of reminiscence that was utilised to underpin the training intervention was that of simple reminiscence [40] which encompassed mainly unstructured autobiographic storytelling and triggers that generated spontaneous reminiscence, often within a relational context, such as special days or events shared by friends and family. The goal of this approach is to enhance social contacts and short-term well-being while also supporting intergenerational bonding [40,41]. Our intervention was designed to cater for the needs, preferences and interests of the person living with dementia and his/her family carer. In a measure of quality, the reporting of this study adheres to the TREND statement [42].

**Table 1: Intervention activities and data collection time-points**

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|  | **Pre-intervention** | **19-week Intervention** |
| **Timescale** | **Baseline** | **Weeks 1-6 Training**  | **Week 7-19 Reminiscence using iPad App** |
| **Activities** |  | Rem TrainingPackage5 sessions | IT Training Package3 sessions | Home Rembegins week 7 | Home Rem continues in week 13    | Home Rem ends in week 19 |
| **Data collection Time-points**  | Baseline **T0** |  |  |  | Mid-point **T1** | End-point **T2** |
| **Repeated measures** | MutualityWHO-5QCPR |  |  |  | MutualityWHO-5QCPR | MutualityWHO-5QCPR |
|  |  |  |  |  |  |  |  |

Abbreviations: Reminiscence [Rem], Information Technology [IT]

### Settings

The setting was a large health and social care trust in a region of the UK. The Trust catchment area is a mix of rural and urban communities serving a population of approximately 300,000 people with an estimated 2717 of these, living with a dementia. Recruitment was facilitated by the Trust’s community mental health team for older people and through the Trust’s cognitive rehabilitation team, as engagement with the latter was indicative of a diagnosis of early to moderate dementia.

### Participants

A purposive sampling strategy was used to recruit 30 care-giving dyads (30 persons with dementia and 30 carers). A sample size of 40 – 50 is recommended as sufficient for a feasibility study to estimate the total sample size across parameters to inform a future RCT [43]. Our participants were predominantly older people, and there was potential for significant drop outs. With that in mind, we increased our sample to 60.

Inclusion and exclusion criteria were developed to minimise potential for bias in the recruitment process. All people who 1) had a diagnosis of early to moderate dementia, 2) were able to communicate and understand communication and 3) were aware of his/her dementia diagnosis, and their family carers who were 1) aged 18 or over, 2) caring for a family member living with dementia meeting the above criteria (either co-habiting or non-co-habiting) and 3) aware of his/her relative’s dementia diagnosis, were invited to consider participating in the study. People with a major illness or disability that hindered their ability to engage in the study were excluded. Recruitment commenced in April 2016 and continued until the sample size of 30 dyads (n=60) was achieved in October 2016.

Ethical considerations principally pertained to voluntariness, supporting separate informed consent from the person living with dementia and their carer, handling and storage of data, and right to withdraw from the study. The study received ethical approval (REC Ref 16/NI/0002) in line with regional and NHS Trust research governance.

### Primary outcome measure

The primary outcome measure was Mutuality, defined as the positive quality of the relationship between carer and care recipient [26]. The Mutuality scale consists of 15 items. A sample item includes “How attached are you to him or her”. A five-point scale is used, ranging from 0 (not at all) to 4 (a great deal). Higher scores indicate a higher level of mutuality, which may support relationships in difficult circumstances. The Mutuality scale has been tested for validity in previous studies of family care-giving and has demonstrated internal consistency [44,45]. The mean is calculated across the response scores for data analysis [45,46].

### Secondary outcome measures

The secondary outcome measures comprised Quality of the Carer and Patient Relationship scale [28] and WHO-5 Well-Being Index [27,47]. The Quality of Carer and Patient Relationship scale [QCPR] is a 14-item scale measuring relationship quality, including level of warmth and level of criticism. The scale has demonstrated good internal consistency and concurrent validity with other measures of relationship quality and carer stress [48]. Responses are rated using a 5-point Likert scale, scored from 1 – 5, ranging from totally disagree to totally agree. The six items measuring criticism and conflict are reverse scored in computation [28]. Total QCPR scores are utilised for data analysis. A total score greater than 42 is indicative of a good relationship.

The WHO-5 Well-Being Index comprises five questions that tap into the subjective well-being of participants. WHO-5 has been extensively tested for validity [49,50] and reliability [51,52]HYPERLINK "http://www.ncbi.nlm.nih.gov/pubmed?term=L%C3%B6we%20B%5BAuthor%5D&cauthor=true&cauthor\_uid=14706723"HYPERLINK http://www.ncbi.nlm.nih.gov/pubmed?term=L%C3%B6we%20B%5BAuthor%5D&cauthor=true&cauthor\_uid=14706723. WHO-5 scale items are scored from 0 – 5, and then totalled, giving a potential raw score ranging from 0 – 25. It is recommended that in studies that are assessing for change over time that the WHO-5 raw scores are transformed to percentage scores for data analysis [53]. A total percentage score of 50 or less is an indication of low mood, and a score of 28 or less suggests likely depression warranting further assessment.

### Intervention and Follow-up

Participating dyads were provided with a new touch screen tablet device which hosted the novel InspireD reminiscence app. A package of five reminiscence training sessions influenced by evidenced informed guidelines [40,41], was delivered by a reminiscence trainer employed by the Reminiscence Network NI. Three IT training sessions were then provided by an IT assistant to support the participants in uploading their personal memorabilia and to use the reminiscence app independently. The reminiscence and IT training packages were provided face to face, in the homes of participants living with dementia. The estimated costs of the intervention which included the training package together with the cost of the InspireD system was £2570 per dyad. After training was completed, participants were requested to engage in simple reminiscing through the app on three days per week for the following 12 weeks. Compliance was supported by a user-friendly instruction booklet. A phone number for the IT trainer was provided, should a technological issue arise.

Participants were followed up for a period of 19 weeks from baseline (T0), as outlined in Table 1. Midpoint measurement data (T1) were collected in week 13 from baseline, which was 6 weeks into the independent use of the reminiscence technology. Endpoint measurement data were collected in week 19 at close of the intervention (T2). The data collection period was May 2016 – February 2017. Due to the nature of the study design, there was no control group, and due to the nature of the intervention, it was not possible to blind participants, nor the trainers administering the intervention. All data were uploaded to IBM SPSS version 23 [54] using unique anonymised identification codes by the research assistant. The researcher with responsibility for analysing the data and interpreting the results, worked from that anonymised data set.

### Statistical analysis

Descriptive statistics were used to describe and synthesise the data pertaining to the characteristics of the participants. Missing data analysis as recommended were undertaken to discern possible patterns and challenges in the selected measurement tools [55]. Chi-square tests were conducted for analysis of nominal variables. Independent t-tests were undertaken to compare measurement scores in Mutuality, QCPR and WHO-5 across the dyad relationship (person living with dementia and carer) and across gender at baseline. Paired t-tests investigated differences in scores across two time-points. Within and between repeated measures analysis of variance investigated the impact of the intervention over time. Correlational tests were used to investigate relationships between continuous variables. On an intention to treat basis [55,56], missing data for Mutuality, QCPR and WHO-5 were managed using the expectation-maximization imputation approach.

## Results

### Baseline assessment

A baseline assessment of demographic details, Mutuality, QCPR, and WHO-5 was conducted prior to the programme of reminiscence and IT training. Sixty participants, in thirty dyads, were recruited to the study. Of these, a total of 58 participants (29 dyads) were retained in the study at completion. The characteristics of participants and baseline measurement scores are presented in Table 2. The majority (n=20; 67%) of the participants with dementia were men. A chi-square test for independence (with Yates continuity correction) was conducted, and revealed that this was significantly different to the gender composition of the carer participants. The carers were predominantly women (n=24; 80%; p = .001). The age range of participants living with dementia was 61 - 94 years. The age range of the carers was 31 – 91 years. An independent t-test revealed that the age of the carers (M = 67; SD = 14.8) was significantly lower than that of the participants living with dementia (M = 79; SD = 8.9, P < .001). In 23 of the dyads, the carer was living in the same house as the participant living with dementia. The majority ofthe participants living with dementia had little or no IT experience, whereas the majority of carer participants had at least moderate IT experience.

**Table 2:** Baseline characteristics of participants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Characteristic | Total  | Adults with dementia  | Family carers  | *P*-values |
| **Demographics** n (%) | 60 (100%) | 30 (50%) | 30 (50%) |  |
| Age (mean, SD)  | (73, 13) | (79, 8.9) | (67,14.8) | <.001 |
| Age range | 31-94 | 61-94 | 31-91 |  |
| **Gender** |  |  |  |  |
| Male, n (%) | 26 (43%) | 20 (67%) |  6 (20%) |  |
| Female, n (%) | 34 (57%) | 10 (33%) | 24 (80%) | .001 |
| **Marital status** |  |  |  |  |
| Married, n (%) | 47 (78.3%) | 22 (73%) | 25 (83.3%) |  |
| Widowed, n (%) | 9 (15%) | 8 (27%) | 1 (3.3%) |  |
| Separated/single, n (%) | 4 (6.7%) | 0 (0%) | 4 (13.3%) |  |
| **IT experience** |  |  |  |  |
|  Little or none,n (%) | 35 (58%) | 24 (80%) | 11 (37%)  |  |
|  Moderate, n (%) | 21 (35%) | 5 (17%) | 16 (53%) |  |
|  A lot, n (%) | 4 (7%) | 1 (3%) | 3 (10%) |  |
| **Home internet access** |  |  |  |  |
| Home internet access, n (%) | 52 (87%) | 25 (83%) | 27 (90%) |  |
| **Hobby choices**  |  |  |  |  |
|  Social,n (%) | 29 (48%) | 14 (47%) | 15 (50%) |  |
|  Physical fitness, n (%) | 19 (32%) | 8 (27%) | 11 (37%) |  |
|  Creative, n (%) | 7 (12%) | 4 (13%) | 3 (10%) |  |
|  No hobby, n (%) | 5 (8.3%) | 4 (13%) | 1 (3%) |  |
| **Repeated Measures**  |  |  |  |  |
|  Mutuality (mean, SD) | (3.13, .68) | (3.24, .54) | (3.02, .79) | .22 |
|  QCPR (mean, SD) | (57.4, 7.9) | (58.1, 7.1) | (56.7, 8.6) | .52 |
|  WHO-5 (mean, SD) | (61.0, 23.9) | (60.8, 26.2) | (61.2, 21.8) | .94 |
| 1. An independent *t*-test compared age across participants grouped by ‘adults living with dementia’ and ‘family carers’. Participants living with dementia had significantly higher age. Chi-square test for independence (with Yates continuity correction) was conducted to compare gender across the two groups. There was a significant difference in the gender composition of the groups. Chi-square tests were not conducted when numbers in categories were less than 5. Independent *t-*tests compared baseline mutuality, QCR and WHO-5 scores between the two groups. There was no significant difference in the scores at baseline. *P*-values < 0.05 indicate significance.
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There were no missing data at baseline. Mean mutuality score at baseline was 3.13 (SD = .68), indicating a moderate level of closeness in the relationship. Visual inspection of the histogram and Q-Q plots indicated a reasonable but positively skewed distribution. There was no significant difference in baseline mutuality for participants with dementia and carers (p = .218). There was a statistically significant difference in mutuality for men (M = 2.9; SD = .78) and women (M = 3.3; SD = .56) with women having the higher scores (95% *CI:* -.756 - -.026; p = .036). No relationship was discerned between age and baseline mutuality (r = .09).

Mean QCPR was 57.4 (SD = 7.9), indicating of a good relationship. A Kolmogorov-Smirnov statistic of .057 was suggestive of a normal distribution, supported by visual inspection of histograms and Q-Q Plots. There was no significant difference in baseline QCPR for participants with dementia and carers (p = .52), nor between men and women (p = .914). There was a positive but weak correlation between age and QCPR (r = .123), that failed to reach statistical significance (p = .349).

Mean WHO-5 was 61.0 (SD = 23.9), indicating a moderate level of subjective well-being. The Shapiro-Wilks statistic (appropriate for a small sample) of .052 suggested normality, and this was supported by visual inspection of histogram and Q-Q plots. There was no significant difference in WHO-5 for participants with dementia and carers (p = .94), nor between men and women (p = .40). No relationship was discerned between age and baseline WHO-5 (r = -.04).

### Missing data analysis

At time-point 1 (midpoint), three (5%) participants had missing data: participant 50 had 2.9% missing data; participant 11 had 5.9% missing data; and participant 44 was unavailable for data collection due to a hospital admission. At time-point 2 (endpoint), four (6.6%) participants had missing data: participant 20 had 2.9% missing data, participant 43 was unavailable due to a hospital admission, one participant had died and her carer withdrew from the study.

### Intention to Treat analysis

Paired-samples t-tests were conducted to compare baseline and endpoint measurement scores. There was a statistically significant increase in mutuality scores of participants living with dementia from baseline (M = 3.24, SD = .545) to endpoint (M = 3.64, SD = .274, *95%* *CI:* -.56 - -.23; p < .001 two-tailed). There was also a statistically significant increase in QCPR scores of participants with dementia from baseline (M = 58.07.4, SD = 7.12) to endpoint (M = 63.2, SD = 4.32, *95%* CI: -7.42 - -2.84; p < .001, two-tailed). Similarly, there was a statistically significant increase in WHO-5 scores of participants with dementia from baseline (M = 60.8, SD = 26.2) to endpoint (M = 70.6, SD = 21.4, *95% CI:* -14.8 - -4.84; p < .001 two-tailed).

In relation to the carers, there was an increase in mutuality from baseline (M = 3.02, SD = .79) to endpoint (M = 3.07, SD = .60), but the increase was not statistically significant (p = .52). Similarly, an increase in carer QCPR scores from baseline (M = 56.7, SD = 8.66) to endpoint (M = 57.9, SD = 8.26) was not statistically significant (p = .28). There was a decrease in carer WHO-5 scores from baseline (M = 61.2, SD = 21.8) to endpoint (M = 60.2, SD = 23.4). The change in carer WHO-5 was not statistically significant (p = .74).

Mixed between-within subjects analysis of variance was conducted to assess the impact of the reminiscence intervention over time and between participants living with dementia and the carers. For the participants with dementia, mean mutuality increased from baseline to mid-point and then further increased at end-point. For the carers, mean mutuality peaked at mid-point. A similar pattern for participants living with dementia and carers was observed in mean QCPR scores over time. In relation to WHO-5, the mean scores of participants living with dementia increased from baseline to mid-point with a further increase at end-point. For the carers, mean WHO-5 decreased from baseline to mid-point, and then increased to end point. Mean outcome measurement scores, standard deviations, time related p-values, and pattern difference p-values are presented in Table 3.

A statistically significant effect of the intervention on mutuality was demonstrated over time, Wilks’ Lambda = .77, F (2, 57) = 8.17, p = .001, partial eta squared = .22. The pattern of mutuality scores for the participants with dementia and the carers was significantly different (Wilks’ Lambda = .87, F(2, 57) = 4.23, p = .019, partial eta squared = .129), with participants living with dementia attaining higher scores. A statistically significant effect of the intervention on QCPR was demonstrated over time (Wilks’ Lambda = .777, F (2, 57) = 8.15, p = .001, partial eta squared = .223). The pattern of QCR scores for participants with dementia and carers was statistically significant (Wilks’ Lambda = .88, F(2, 57) = 3.72, p = .03, partial eta squared = .116). The participants living with dementia had attained higher scores. Overall, the intervention did not demonstrate a significant effect on WHO-5 over time, Wilks’ Lambda = .90, F (2, 57) = 2.94, p = .06, partial eta squared = .09. However, a statistically significant difference was found in the pattern of scores between the participants living with dementia and the carers, Wilks’ Lambda = .85, F(2, 57) = 4.90, p = .011, partial eta squared = .147. The participants living with dementia had a higher pattern of scores.

**Table 3.** Measures across time

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Measure | Participant | T0mean ± SD | T1mean ± SD | T2mean ± SD | N | Time *p*-values | Pattern  *p*-values |
| Mutuality | PLWD | 3.2 ± .556 | 3.6 ± .203 | 3.6 ± .275 | 30 |  |  |
| Carer | 3.0 ± .799 | 3.1 ± .67 | 3.1 ± .601 | 30 |  | .019 |
| Total | 3.1 ± .687 | 3.4 ± .55 | 3.4 ± .543 | 60 | .001 |  |
| QCPR | PLWD | 58.1 ± 7.1 | 61.3 ± 5.2 | 63.2 ± 4.3 | 30 |  |  |
| Carer | 56.8 ± 8.7 | 58.6 ± 7.4 | 58.9 ± 8.3 | 30 |  | .03 |
| Total | 57.4 ± 7.9 | 59.9 ± 6.5 | 60.6 ± 7.0 | 60 | .001 |  |
| WHO-5 | PLWD | 60.8 ± 26 | 69.9 ± 18 | 70.7 ± 21 | 30 |  |  |
| Carer | 61.2 ± 22 | 56.5 ± 27 | 60.3 ± 23 | 30 |  | .01 |
| Total | 61.0 ± 24 | 63.2 ± 24 | 65.5 ± 23 | 60 | .06 |  |
| Abbreviations: Person living with dementia [PWLD], T0 [Baseline], T1 [Midpoint], T2 [Endpoint]. Mixed between-within subjects analysis of variance assessed the impact of the reminiscence intervention over time and between participants living with dementia and the carers. Statistically significant effects on mutuality (p=.001) and on QCPR (p=.001) were demonstrated over time. The patterns of mutuality scores (p=.019), QCPR (p=.03) and WHO-5 (p=.011) were significantly different for PLWD and carers.  |

### Estimation of sample size for a future RCT

A linear mixed model for a 2-way repeated measures ANOVA (fixed effects) was used to analyse the data. The between effect is dyad role, that is participants living with dementia versus carers. The statistical power for the between effect in the model, based on the results from the mutuality measure, was 36 individuals per group (total = 72).  The power to detect the effects was set at 0.9 in all of the analyses.

For within effect (repeated measures for both carers and those living with dementia), to detect the main effect of time (within subject effect) a sample of 16 respondents would be required in each group (total = 32). For between-within subjects (interaction), to detect the interaction of condition (carer vs those living with dementia) and time would require a sample of 39 individuals in each condition (total = 78) to detect an effect similar to that present in the previous study, with a statistical power of 0.9.

## Discussion

### Principal findings

This quasi-experimental study sought to appraise outcomes from a feasibility study of individual specific reminiscence facilitated by a programme of training and an iPad app. A total of 58 participants (29 dyads) were retained in the study at completion, supporting the understanding that neither age nor a diagnosis of dementia are barriers to engagement in home-based research and with technology. The main findings from the study are 1) statistically significant increases in mutuality, quality of carer and patient relationship and emotional wellbeing for participants living with dementia, from baseline to endpoint; 2) non-significant increases in Mutuality and QCPR, and a non-significant decrease in WHO-5 for the carer participants from baseline to endpoint; and 3) statistically significant differences in patterns of intervention effect across time, with the participants living with dementia attaining higher patterns of scores. It is difficult to determine the clinical significance of these changes as this was outside the remit of this feasibility study. However, a future RCT could include additional scales such as the mini-mental state examination [57] and Geriatric Depression Scale Short Form [58] in repeated measures testing.

### Comparison with prior work

There is increasing use of mobile computer software and rising acceptability of health promotion apps internationally [29, 59-62]. It was foreseen that the future would bring opportunities for reminiscing facilitated by touch-screen interfaces [10]. Ours was a feasibility study with the purposes of testing a novel intervention of individual specific reminiscence and investigating impact. The total number of participants (n=60) recruited to this study is a significant increase from previous technology enabled reminiscence studies [12]. The three outcome measures utilised in our study were Mutuality [26], Quality of the Carer and Patient Relationship [28] and WHO-5 Well-Being Index [47]. A strength of our study, is that all three tools have previously undergone extensive testing for validity and reliability, and were sufficiently sensitive to deliver statistically significant results. Our reminiscence intervention differed in a number of ways to the approaches taken in recent studies [12]. Our intervention was 1) home-based, 2) the participating dyads received a programme of individual specific training in reminiscing and information technology, and 3) the reminiscing activity was supported by an iPad app hosted on tablet software with each of the participants having his/her own unique access log-in details. Our findings suggest that technology based reminiscence may be able to support mutuality and quality of informal care-giving relationships, and contrast with negative trends observed in longitudinal studies among care-giving dyads [22, 44]. We cannot make direct comparisons between our results and those of other technology based reminiscence research due to the lack of appraisal of outcome in previous research. Our findings however, add to the emerging evidence that technology based reminiscence offers benefits in the context of family care-giving in dementia [12,15,18].

It is acknowledged internationally that family carers are the most important practical, personal and economic supports for people with dementia [7,8], and that enduring care-giving roles in the context of dementia are associated with significant negative trends in mutuality and quality of life among family carers [22]. It would therefore not have been surprising if we had found significant negative trends in the outcome scores of carers over the course of our study. Our decision to deliver a home-based intervention, was informed by research that suggested that research participation can pose a significant challenge on carers of people living with dementia [48]. Our research findings suggest that it is possible that the home-based nature of our intervention contributed to the statistically significant enhancements for participants with dementia, with no significant detriment to carers. To what extent, carers would continue to support the intervention in a longer duration study is worthy of consideration. It may be possible to develop the i-Pad app further to utilise a coaching companion to prompt, incentivise and reward the carer. Together our findings support the need for a robust randomised controlled trial of home-based app-enabled personalised reminiscence. A stratified sampling strategy guided by mini-mental state examination scores, with matched controls, and longer follow-up time of up to two years would address the unknown issue of how long the intervention effect might last.

### Limitations

This was a feasibility study, and it was important to maximise exposure to the novel technology based personalised reminiscence intervention. There are acknowledged challenges in the recruitment of people living with dementia and their family carers, and use of a comparison group would have reduced exposure to the intervention. Quasi-experimental designs, such as that which we adopted cannot establish cause-and-effect relationships with certainty, but they can establish strong links. The authors cannot rule out a Hawthorne effect given the trial design, and the possibility that pre-existing factors have influenced the results. Conclusions therefore have to be interpreted with caution. An additional limitation is the under-representation of women among the participants living with dementia in our study, given that women have been constituted as a marginalised majority in UK prevalence of dementia [63].

## Conclusions

Reminiscence has been promoted internationally as a means of enhancing standards of care and quality of life for people living with dementia and their family carers. Our study comprised a novel intervention of home-based reminiscence with repeated measures testing. The findings of this study indicate statistically significant enhancements in mutuality, quality of relationship and subjective well-being for the participants living with dementia, and non-significant enhancements in mutuality and quality of relationship for carers. These findings support an emerging body of evidence that purports that individual specific psychosocial interventions have efficacy in the context of dementia. It is important to highlight that our study is not without limitations and that pre-existing factors may have influenced the results. Nonetheless, our intervention, comprising a programme of training and use of a novel i-Pad app, may contribute to the on-going development of home-based reminiscence in the context of dementia. Future research must be cognisant of the potential for women living with dementia to be under represented among participants, and the importance of controlling pre-existing factors. A robust randomised controlled trial of personalised reminiscence is worthy of consideration.

## Acknowledgements

This work was funded by the Public Health Agency Research and Development Office and Atlantic Philanthropies (COM/5016/14). The authors would like to thank the Reminiscence Network Northern Ireland and people living with dementia and their carers for their input in the co-creation and design of the InspireD app, and the Trust’s Cognitive Rehabilitation Team for facilitating recruitment. Special thanks to Alex Turnbull from Kainos for invaluable assistance in early stage technology selection decisions.

## Authors’ Contributions

EL was responsible for study design, review board’s approval, data collection, statistical analysis, interpretation of results, and manuscript preparation. AR was responsible for study design and management, review board’s approval, recruitment, data collection, interpretation of results, and manuscript preparation. CMcC was responsible for recruitment, data collection and manuscript preparation. RB and MM were responsible for ecological momentary assessment, design and analysis, interpretation of results, and manuscript preparation. KC was responsible for study design, InspireD app development and manuscript preparation. BB and FF were responsible for study design, interpretation of results and manuscript preparation. AG was responsible for InspireD app development, data collection and manuscript preparation.

## Conflict of Interest

None declared.

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