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ESTIMULAÇÃO DA MEMÓRIA NA DOENÇA DE ALZHEIMER EM FASE INICIAL: O PAPEL DA SENSECAM NO FUNCIONAMENTO COGNITIVO E NO BEM-ESTAR

Tese de Doutoramento em Psicologia, na especialidade de Neuropsicologia, orientada pela Professora Doutora Maria Salomé Ferreira Estima Pinho, pelo Professor Doutor Christopher Moulin e pelo Professor Doutor Luís Lopes Macedo, apresentada à Faculdade de Psicologia e de Ciências da Educação da Universidade de Coimbra

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Aos avós do coração Mário e Dorinda

À filha Maria

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RESUMO

Introdução: A doença de Alzheimer (DA) é a forma mais comum de demência e a sua manifestação clínica evidencia défices primariamente mnésicos, progressivamente generalizados a outros domínios cognitivos. O decréscimo cognitivo com caráter progressivo interfere significativamente no bem-estar dos pacientes com DA, afetando o seu estado de humor e a sua funcionalidade diária. Embora a primeira linha de atuação nesta doença, após o diagnóstico, seja o tratamento farmacológico, há um consenso crescente relativamente à urgência de complementar esta atuação com a implementação de intervenções não farmacológicas, de modo a reduzir o impacto da doença. A Reabilitação Neuropsicológica (RN) foi a abordagem não farmacológica inicialmente implementada com estes pacientes, mas o facto de se basear no treino cognitivo intensivo e repetitivo levou a que estas intervenções apresentassem poucos benefícios na DA, nomeadamente devido a um elevado número de desistências do tratamento e dos ganhos se circunscreverem ao momento imediato. A pouca utilidade das intervenções baseadas na RN para a DA alterou-se, no início deste século, com o surgimento de estratégias internas de estimulação cognitiva (como a aprendizagem sem erros, a recuperação espaçada e o desvanecimento de pistas) tendo um conjunto vasto de estudos mostrado a sua eficácia na potenciação das capacidades preservadas destes pacientes e na facilitação da capacidade de aprendizagem que a plasticidade cerebral remanescente ainda permite na fase inicial da DA. Paralelamente, ocorreu também uma maior disseminação de estratégias externas de estimulação cognitiva na DA, denominadas "próteses cognitivas". Os avanços tecnológicos conduziram ao desenvolvimento de ferramentas mais eficazes e menos exigentes do ponto de vista dos recursos cognitivos necessários para a sua utilização, o que pode ajudar os pacientes a compensar as suas limitações cognitivas. Neste contexto, surgiu a SenseCam – uma câmara fotográfica automática portátil, que capta imagens do dia-a-dia vivenciado pelos pacientes, a partir da sua perspetiva. Os resultados promissores dos primeiros estudos clínicos com esta prótese cognitiva justificaram a sua utilização no presente estudo. Ancorada num paradigma de RN, a presente investigação centrou-se na compreensão da eficácia da utilização da SenseCam, como ferramenta de estimulação cognitiva, procurando: a) conhecer os efeitos deste dispositivo no desempenho cognitivo e no bem-estar de pacientes com DA em fase inicial e b) comparar os efeitos desta estratégia externa de RN relativamente a um conjunto de estratégias internas (programa Memo+) aplicadas a estes pacientes. De forma complementar, procurámos perceber em que medida as competências metacognitivas (de tomada de consciência das capacidades cognitivas por parte dos pacientes) seriam potenciadas através da participação em sessões de estimulação cognitiva.

Metodologia: A presente investigação é de natureza transversal. Principiámos por examinar a utilidade de instrumentos de avaliação neuropsicológica enquanto medidas de eficácia para examinar os efeitos da SenseCam numa amostra de 29 adultos saudáveis (15 adultos jovens e 14 adultos idosos), tendo recolhido dados sobre a eficácia imediata no desempenho mnésico da utilização da SenseCam durante três dias. Seguidamente, procedemos ao estudo principal no qual avaliámos a eficácia da SenseCam comparativamente com um programa de treino cognitivo (Memo+) e um diário escrito, com a duração de seis semanas, no desempenho cognitivo e no bem-estar (examinado através da avaliação do humor deprimido, da capacidade funcional e da qualidade de vida, do ponto de vista do paciente) de 51 pacientes com diagnóstico de DA em fase inicial. Neste estudo, examinámos, além da eficácia imediata, a eficácia a longo prazo das três intervenções (SenseCam, Memo+ e diário), seis meses após o términus das sessões de estimulação cognitiva.

Resultados: A intervenção baseada na SenseCam permitiu, de uma maneira geral, melhorar o desempenho cognitivo dos participantes, quer no estudo piloto com adultos jovens e idosos saudáveis quer no estudo clínico com os pacientes com DA inicial. Para os pacientes com DA verificou-se, imediatamente e seis meses após a intervenção com a SenseCam, um desempenho mnésico autobiográfico superior ao desempenho de base, e mais elevado relativamente às intervenções Memo+ e ao diário escrito. Esta intervenção apresentou um benefício idêntico ao programa Memo+ no desempenho mnésico global e em algumas medidas de funcionamento executivo. Relativamente às medidas não cognitivas utilizadas, as intervenções com recurso à SenseCam e ao Memo+ permitiram a diminuição dos sintomas depressivos e a perceção de menos disfuncionalidade, por comparação com a intervenção baseada no diário. Contudo, contrariamente aos efeitos cognitivos, estes efeitos não se mantiveram após seis meses. Finalmente, no que concerne ao impacto das intervenções ao nível da metacognição, nenhuma delas contribuiu para aumentar o nível de exatidão dos julgamentos de desempenho cognitivo por parte dos pacientes examinados. Estes continuaram a sobrestimar o seu desempenho, independentemente da participação em intervenções de estimulação cognitiva, e do feedback recebido.

Conclusões: De um modo global e não obstante as limitações da presente investigação (do ponto de vista amostral e da adequação das medidas de eficácia utilizadas), estes resultados reforçam a importância do desenvolvimento de intervenções não farmacológicas para pacientes com DA em fase inicial, de modo particular aquelas que radicam nos princípios da RN e nos avanços mais recentes, quer relativos a estratégias internas quer a estratégias externas de estimulação cognitiva. A intervenção com recurso à SenseCam afigura-se como alternativa a intervenções baseadas em estratégias internas, mais exigentes para os pacientes e para os terapeutas. Por outro lado, a eficácia observada do programa multitarefas Memo+, construído para ser testado na presente investigação, com base em estratégias internas de estimulação cognitiva referidas na literatura como eficazes na potenciação das capacidades cognitivas remanescentes, revela que também esta intervenção, de natureza de restituição funcional e não de compensação, tem utilidade para os pacientes com DA em fase inicial. Contudo, os efeitos limitados de ambas as intervenções (SenseCam e Memo+) a respeito do bem-estar geral destes pacientes sugerem a necessidade de aprofundamento dos resultados encontrados. Linhas investigacionais futuras deverão examinar em que medida a atuação conjunta destas intervenções, que a presente investigação mostrou como sendo eficazes, potenciam essa mesma eficácia e contribuem, significativamente, para o aumento do bem-estar a longo prazo dos pacientes com DA inicial.

Palavras chave: doença de Alzheimer; memória; SenseCam; reabilitação neuropsicológica; intervenções não farmacológicas; cognição; bem-estar.

ABSTRACT

Introduction: The Alzheimer's disease (AD) is the most common type of dementia, and its clinical presentation is characterized by memory deficits, at first, followed by progressive generalized cognitive deficits. The cognitive impairment with a gradual character affects significantly AD patients' well-being, mainly their emotional state and daily function. Although the first line of treatment, after de diagnosis, is the pharmacological, there is a growing consensus regarding the need to complement these treatments with non-pharmacological interventions, in order to reduce the impact of the disease. Neuropsychological Rehabilitation (NR) is the non-pharmacological intervention paradigm first implemented with these patients. However, the fact that it requires intensive and repetitive cognitive training brought limited benefits for AD patients, due to frequent dropouts and limited effects not generalized to long term. The utility of the NR interventions in AD changed in the beginning of this century, with the appearance of cognitive stimulation based on internal strategies (such as errorless learning, spaced retrieval, and vanishing cues) that a wide range of studies showed their efficacy in the optimization of preserved abilities and also in the facilitation of learning abilities that the mild stage of AD still allows. At the same time, a strong focus in external strategies for cognitive stimulation in AD also raised, namely in the domain of the "cognitive prosthetics". Technological advances led to the development of effective less demanding tools regarding the cognitive resources they required for its use, as so becoming helpful for these patients to compensate for their cognitive deficits. In this context, the device Sensecam was built – a wearable and automatic camera, that captures images from patients' daily life, from their perspective. The promising findings from the first clinical studies with this cognitive prosthetic tool justify the choice of this device to be tested in the present research. Based in the NR paradigm, this research focused on the understanding of the effectiveness of the SenseCam use, as a tool of cognitive stimulation, with the aims of: a) to know the effects of this tool in cognitive performance and well-being of patients with mild AD and b) to compare the effects of this external strategy with a programme of training based on internal strategies' (Memo+) applied to these patients. Additionally, we looked to promote a deeper understanding about how metacognitive abilities of these patients (awareness about oneself cognitive abilities) are stimulated with the participation in sessions of cognitive stimulation.

Methods: The present research is cross-sectional. We examined first the utility of a set of neuropsychological assessment instruments as outcome measures to test the effects of the SenseCam in a sample of 29 healthy adults (15 young adults and 14 older adults), and we collected data about the immediate effects on memory performance of the SenseCam use during three days. We then proceed to the main study in which we assessed the efficacy of SenseCam use, comparatively to a cognitive training programme (Memo+) and to a written diary, during six weeks of training, concerning the cognitive performance, state of humour and well-being (examined through the evaluation of depressive symptoms, functional capacity and quality of life) in a sample of 51 patients with mild AD. In this study beyond the evaluation of the immediate effects we also tested the long term effects of the three interventions (SenseCam, Memo+ and diary) in a six-months follow-up.

Results: The cognitive intervention based in the SenseCam device contributed, in general, to ameliorate the cognitive performance of the participants, both in the pilot study with healthy young and older adults and in the clinical study with mild AD patients. For the AD patients it was found, immediately and six months after the intervention with SenseCam, an increase in autobiographical memory performance compared to baseline and compared to the Memo+ and the diary interventions. The SenseCam intervention showed an equivalent effect to the programme Memo+ in most measures of memory and in some measures of executive function. Regarding non-cognitive measures used in this study, both the SenseCam and Memo+ interventions contributed to a decrease of depressive symptomatology and also to a diminution in the self-perceived dysfunctionality, comparatively to the diary intervention. However, contrary to the effects in cognition, these effects were not maintained at follow-up. At end, concerning the impact of the cognitive interventions in metacognitive abilities, none contributed to increase the accuracy rates of memory abilities in this sample of mild AD patients. They maintaining an overestimation of performance independently of the intervention of cognitive stimulation applied and to the feedback received.

Conclusions: Globally, and despite the limitations of the present research (regarding the sample size and the suitability of the outcome measures applied) these results increase the relevance of the development of non-pharmacological interventions for patients with mild AD, particularly those based in NR and in the most recent developments regarding internal and external strategies of cognitive stimulation. Interventions using the device SenseCam appear as good alternative to the interventions based on rehearsal of internal cognitive strategies, more demanding for both the patients and the therapists. On the other side, the observed efficacy of the multi-task programme Memo+, designed to be tested in the present investigation and based on documented effective internal strategies of cognitive improvement to optimize preserved abilities, reveals that this intervention, aimed to optimize instead of compensate for the deficits, is also useful for patients with mild AD. However, the limited effects of both interventions (the SenseCam and the Memo+) regarding well-being of the patients suggest the need for further probe of these results. Future lines of research should examine to what extent the conjoint utilization of the interventions that this research revealed to be effective amplify its effectiveness and contribute significantly to the increase of well-being in the long term of the patients with mild AD.

Key words: Alzheimer's disease; memory; SenseCam; neuropsychological rehabilitation; non-pharmacological interventions; cognition; well-being.

"Enquanto não alcances não descanses.

De nenhum fruto queiras só metade."

(Miguel Torga)

INTRODUÇÃO

1. Doença de Alzheimer: epidemiologia e intervenções

De todas as formas de demência conhecida, a doença de Alzheimer (DA) é, atualmente, o tipo mais comum em adultos com mais 65 anos (Hodges, 2006), constituindo cerca de 60 a 80% dos casos de demência. Presentemente, a DA afeta cerca de 40 milhões de pessoas em todo o mundo. Contudo, em 2050, prevê-se que a mesma afetará 150 milhões de pessoas – alguns de nós, atualmente investigadores, psicólogos, neuropsicólogos, estudantes ou simplesmente leitores, estaremos incluídos neste número. Se o nosso tempo de vida se aproximar dos 85 ou mais anos, a probabilidade de desenvolver DA é aproximadamente de 50%, i.ee. de um para dois (Thompson & Toga, 2009).

Em grande parte dos últimos 100 anos, a DA foi confundida por muitos, incluindo cientistas, com um processo de senescência associado ao envelhecimento saudável. A perda capacidades cognitivas globais de forma progressiva e incapacitante era aceite enquanto processo normal associado ao envelhecimento (Whalley, 2002). A evolução das técnicas de neuroimagem permite-nos hoje olhar para uma imagem do cérebro de um idoso saudável e compará-la com a de um idoso com DA e constatar o dano cerebral evidente causado por esta doença. De uma maneira geral, um sintoma-chave da DA é a perda de memória (e.g., Nixon, 1996), perda essa progressiva e generalizada ao longo do curso da doença (e.g., Duff & Grabowski, 2008; Manning & Ducharme, 2010).

A apresentação amnésica da DA (DA de tipo amnésico, segundo os critérios de McKhann et al., 2011) é a mais comum e é a condição em que os défices da memória são mais evidentes. Indivíduos com DA com este tipo de apresentação clínica têm uma dificuldade acentuada em trazer à consciência eventos passados e em aceder à linha temporal das suas memórias de forma rápida e eficaz. A memória episódica encontra-se em défice desde a fase inicial da doença (e.g., Collette, Van der Linden., Juillerat & Meulemans, 2003). Como tal, quer a memória retrógrada quer a memória anterógrada apresentam um funcionamento deficiente, sobretudo quanto à capacidade de codificar e recuperar informação relativa a experiências recentes. De forma mais específica, os défices na memória autobiográfica – designadamente a capacidade de recuperar informação sobre acontecimentos pessoais relevantes do passado remoto ou recente – são considerados os mais disruptivos na fase inicial da doença e, como tal, constituem sintomas-alvo quer no diagnóstico quer na intervenção na DA (e.g., Greene, Hodges, & Baddeley, 1995; Ivanoiu, Cooper, Shanks, & Venneri, 2004; Kopelman, Wilson & Baddeley, 1989; Piolino, Desgranges, & Eustache, 2000).

Os défices mnésicos estão associados a problemas em outros domínios cognitivos, como a atenção e funções executivas (considerados por alguns investigadores como anteriores ao aparecimento dos défices de memória; Perry & Hodges, 1999), deterioração na produção e compreensão linguística (e.g., anomia e parafasias; Manning & Ducharme, 2010), dificuldades nas funções viso-espaciais e apraxia (Smith & Bondi, 2008). Enquanto elemento crucial do funcionamento diário do ser humano, afetando todas as atividades bem como a própria natureza da experiência subjetiva de cada indivíduo, as habilidades cognitivas em deterioração progressiva e generalizada são a componente central, definidora da DA.

A alteração das funções cognitivas é, desde as fases iniciais e moderadas da doença, acompanhada pelo surgimento de alguns sintomas psicopatológicos e comportamentais (Manning & Ducharme, 2010), sendo frequente a manifestação de sintomatologia depressiva, ansiedade e apatia (Baquero & Martin, 2015). Este declínio gradual das funções cognitivas e afetivas leva a um processo progressivo de deterioração funcional que afeta a autonomia nos indivíduos com DA (Bertolucci, 2005).

A apresentação clínica da DA conduziu recentemente à publicação, pela Organização Mundial de Saúde (OMS) do relatório "Demência: uma prioridade de saúde pública" (OMS, 2012), nono qual são discutidos os custos e as necessidades de atuação, na área da saúde, com os pacientes diagnosticados com DA. Neste relatório, entre outros dados, é referido que, no presente, o custo anual de cuidar das pessoas com demência ronda mais de 604 mil milhões de dólares, na qual se incluem os cuidados de saúde e o acompanhamento social e financeiro destes doentes e dos seus cuidadores. Este relatório refere, ainda, que apenas 8 países em todo o mundo têm um plano de atuação para as demências, não sendo Portugal um desses países. A OMS aponta a urgência do desenvolvimento de um plano nacional para as demências em cada país, que inclua soluções que impulsionem não só o diagnóstico precoce (cada vez mais premente e possível mediante o avanço das técnicas de neuroimagem e biomarcadores) como as intervenções para reduzir a sobrecarga associada à doença. Ainda que o caminho no sentido de um diagnóstico cada vez mais precoce esteja próximo, no que diz respeito às intervenções, o percurso apresenta-se significativamente mais longo e complexo.

A primeira linha de intervenção na DA é farmacológica, sendo os inibidores da colinesterase, bem como a memantina, apresentados como fármacos de primeira linha, com benefícios na redução dos sintomas comportamentais e psicológicos da doença (van Dyck, 2004). A investigação farmacêutica procura atualmente desenvolver tratamentos que possam maximizar ganhos funcionais para estes pacientes (Buschert, Bokde, & Hampel, 2010). Contudo, o esforço dos investigadores para o estabelecimento do diagnóstico precoce da DA trouxe a necessidade de identificar intervenções para indivíduos nas fases iniciais da doença que ainda não apresentam sintomas comportamentais e psicológicos significativos nem deterioração funcional grave (apenas moderada e associada às atividades de vida diária (AVDs) instrumentais; Clare, 2010). Neste contexto começaram a ser estudadas intervenções não farmacológicas, entendidas hoje como um complemento importante e, em alguns casos, alternativo, às intervenções farmacológicas (Salomone, Caraci, Leggio, Fedotova, & Drago, 2012). Resultados do projeto *"European Collaboration on Dementia"* (EUROCODE, 2014) reforçam que no tratamento da DA se deve conciliar a intervenção farmacológica com a intervenção não-farmacológica.

2. Intervenções não farmacológicas na doença de Alzheimer

2.1. Porquê?

A justificação da relevância do desenvolvimento de intervenções não farmacológicas para auxiliar os pacientes com DA nas fases iniciais da doença tem subjacente aa presença de uma plasticidade remanescente do cérebro, que possibilita um nível moderado de modificabilidade, de forma a este reorganizar-se e a adaptar-se a circunstâncias de mudança (Choi & Twamley, 2013). O princípio da plasticidade cerebral era já considerado no âmbito do envelhecimento saudável (Ball, Berch, Helmers, Jobe, Leveck, & Marsiske, 2002; Mahncke et al., 2006) justificando o relevo e consequente eficácia do treino cognitivo. Contudo, apenas recentemente se estudou e concluiu que a plasticidade cerebral permanece, ainda que em níveis mais baixos, em determinadas condições neurodegenerativas como a DA. As recentes investigações propõem que o cérebro de um adulto idoso com DA, cujo diagnóstico foi estabelecido há menos de 18 meses (Zamarron, Fernandéz-Ballesteros, & Tárraga, 2009), é capaz de aprender. Embora os estudos sejam claros quanto ao potencial díspar de aprendizagem entre um cérebro normal e um cérebro afetado por défice cognitivo ligeiro (DCL) e DA, conclui-se que nestas condições de défice é possível modificar o seu desempenho cognitivo através de técnicas de treino (Fernandéz-Ballesteros et al., 2012). Alguns estudos especificam que, quando confrontados um conjunto de palavras, apesar dos pacientes com DA terem um desempenho mais pobre na avaliação de base, depois do treino cognitivo, quer idosos saudáveis, quer pacientes com DA duplicaram o número de itens recordados (Schreiber & Schneider, 2007). A literatura oferece um consenso crescente relativamente ao facto dos pacientes com DA poderem beneficiar da aprendizagem, mediante objetivos de intervenção adequados (Ballesteros, Zamarrón, Tárraga, Moya, & Iñiguez, 2003; Clare, 2007).

As técnicas não farmacológicas de estimulação cognitiva começaram a ser estudadas em finais do século XX, relativamente à sua capacidade de promover este potencial plástico do cérebro (Backman, 1992). Num estudo com recurso à técnica de neuroimagem PET (tomografia por emissão de positrões) com 70 pacientes com DA em fase inicial, ao compararem-se uma intervenção baseada em apoio social, a terapia farmacológica e o treino cognitivo, observou-se que a combinação do treino cognitivo com a terapia farmacológica estava associada a um metabolismo cerebral aumentado em áreas temporoparietais (Heiss, Kessler, Mielke, Szelies, & Herholz., 1994). Num estudo controlo aleatório (randomized controlled trial; RCT) recente (Clare, Linde, Woods, Whitaker, Evans, & Parkinson, 2010), comparando reabilitação cognitiva e com a terapia de relaxamento em pacientes com DA também em fase inicial, foi registado um aumento da atividade BOLD (*blood-oxigen level dependent*) no grupo submetido a reabilitação cognitiva dirigida a áreas cerebrais responsáveis pela aprendizagem e codificação associativa. Por outro lado, a estimulação cognitiva de vária ordem nem sempre pode conduzir a um incremento da atividade cerebral, mas a uma redução em determinadas áreas do cérebro, como sinal de aumento da eficácia na mobilização dos recursos cerebrais necessários ao desempenho de determinada tarefa. Noutro estudo, ainda com recurso a PET (Small et al., 2006), foi testado um programa multidimensional de treino cognitivo, exercício físico e intervenção na redução do stress, tendo-se verificado que os idosos com DCL testados melhoraram o seu desempenho em medidas de fluência verbal e a atividade no córtex pré-frontal dorso lateral esquerdo diminuiu, o mesmo não acontecendo com o grupo de controlo (lista de espera). Segundo Small e colaboradores (2006), esta diminuição da ativação traduz os efeitos da intervenção multidimensional no aumento da proficiência cognitiva de uma área cerebral responsável pela memória de trabalho. Por último, importa realçar que a estimulação cognitiva na DA permite não só alterar os níveis de ativação cerebral, de modo a haver um funcionamento cognitivo mais eficiente por parte dos pacientes com esta doença, mas também modificar o padrão de atividade cerebral. Num estudo de Pariente e colaboradores (2005), foram aplicados exercícios de associação faces-nomes e, em cada sessão num total de quatro, foi realizada uma ressonância magnética funcional, em idosos saudáveis e em idosos com DA inicial. Da análise dos padrões de ativação neuronal, concluiu-se que os idosos com DA evidenciaram uma hiperativação bilateral dos lobos frontais e parietais, queque se supor ser o reflexo das estratégias compensatórias que podem ser recrutadas no cérebro destes pacientes perante a falha na capacidade mnésica associativa que envolve a ativação de áreas temporais e parietais (padrão de ativação apresentado pelos idosos saudáveis).

O conhecimento crescente sobre aquilo que um paciente com DA em fase inicial é capaz de fazer e de mobilizar em termos de recursos cognitivos é o pano de fundo para a dinamização da presente investigação, concebida para testar a eficácia de intervenções não farmacológicas nesta doença. Note-se que, ainda que sejam crescentes os estudos que apresentam várias intervenções eficazes para maximizar o potencial destes pacientes (Bahar-Fuchs, Clare, & Woods, 2013; Clare & Woods, 2004), grande parte dos estudos na DA são estudos de caso ou tiveram como objetivo o exame da eficácia de técnicas isoladas (ver secção *1 do Parte 1 – Reabilitação Neuropsicológica*, para uma descrição do estado da arte quanto a estas intervenções), na ausência de condição de controlo e/ou intervenções em comparação (Clare, 2008, para uma revisão). Existem, contudo, alguns estudos controlo aleatórios com resultados promissores (e.g., Clare, 2010). No sentido de melhorar e qualidade das intervenções não farmacológicas para a DA em fase inicial, e de introduzir estratégias inovadoras a este respeito, foi desenhada a presente investigação

2.2. Como?

As intervenções não farmacológicas para a DA começaram a ser desenvolvidas na década de 80, recorrendo a técnicas de reabilitação da memória, originalmente aplicadas a condições clínicas reversíveis (O'Hara, Mumenthaler & Yesavage, 2000). Estas intervenções compreendem um leque vasto de paradigmas de atuação, nem todos abarcados pela área do saber da Neuropsicologia (ver Olanzaran et al., 2010 para uma revisão). A presente investigação enquadra-se nas intervenções não farmacológicas relacionadas com o paradigma da Reabilitação Neuropsicológica (RN). A definição de reabilitação, *latus sensus*, descreve-a enquanto processo de mudança ativa com o objetivo de capacitar a pessoa com défice para atingir um nível ótimo de funcionamento físico, psicológico e social (McLellan, 1991), implicando a maximização do funcionamento num largo espectro de áreas, como a saúde física, o bem-estar psicológico, a capacidade funcional e social. Embora o paradigma da RN tenha sido primeiramente aplicado a pessoas com défices recuperáveis, não progressivos, é hoje em dia consensual a sua adequação também no contexto da doença neurodegenerativa. Uma das características chave deste tipo de paradigma é a definição individual do seu objetivo/foco de atuação, o qual varia em função das necessidades do indivíduo e da família, de acordo com a severidade da doença. Por definição, a DA afeta necessariamente o funcionamento neuropsicológico (défices cognitivos e manifestação progressiva de sintomas comportamentais e psicológicos). Neste sentido, a RN apresenta-se como particularmente relevante, na perspetiva descrita por Wilson (2009), para estes doentes. Assim, esta dissertação inclui uma secção de recensão teórica na qual se descrevem em detalhe os conceitos e o estado da arte das intervenções baseadas neste paradigma, em adultos idosos sem e com DA (ver *Parte 1 Secção 1*

– *Reabilitação Neuropsicológica*). Na DA, o dano neurológico não pode (até ao momento) ser melhorado/recuperado, havendo, contudo, condições para a redução das limitações funcionais associadas a esse dano, bem como para a atenuação ou eliminação de défices secundários à patologia principal (como a depressão e a perda a autoestima; OMS, 1998). O paradigma de RN passa por considerar a DA como um processo de disfuncionalidade em vez de um processo de doença simplesmente (Clare & Woods, 2003). Sendo assim, o conjunto de intervenções de RN mais adequado para a DA denomina-se de intervenções de estimulação cognitiva: atividades que visam promover um funcionamento cognitivo ótimo de forma a compensar limitações irrecuperáveis, preservando a funcionalidade diária ajustada, por um período o mais longo possível (Alves, Magalhães, Machado, Gonçalves, Sampaio, & Petrosyan, 2014; Grandmaison & Simard, 2003).

As propostas de métodos de RN orientadas para a DA em fase inicial começaram com o desenvolvimento de estratégias internas (assim denominadas por mobilizarem ativamente recursos cognitivos dos indivíduos), com vista à otimização das funções preservadas e à substituição das funções perdidas. A aplicação de técnicas cognitivas como as mnemónicas, a imaginação (que visam a otimização) e, mais recentemente, a recuperação espaçada e aprendizagem sem erros (que visam a substituição), deram origem aos primeiros dados reveladores de eficácia deste tipo de intervenções para a melhoria do desempenho mnésico, foco de atuação primário na DA (Middleton & Schwartz, 2012). As revisões sistemáticas mais atuais indicam que as técnicas de substituição de funções perdidas são mais eficazes do que as restantes para melhorar os resultados obtidos pelos pacientes em testes estandardizados de memória (Haslam, Jetten, Haslam, Pugliese, & Tonks, 2011). Estas considerações motivaram, na presente investigação, a elaboração de um programa de treino cognitivo baseado na aplicação das técnicas referidas (ver *2.2.1.*), para examinar a sua eficácia isolada num programa multitarefa. A par do desenvolvimento de intervenções baseadas em estratégias internas, surgiram também propostas de intervenção orientadas para a compensação das funções perdidas, com o recurso a estratégias externas (assim denominadas por se tratar de agentes externos, como diários, calendários, pagers, etc., utilizados para estimular a mobilização dos recursos cognitivos dos indivíduos; Mulligan, 2008). A investigação com estratégias externas, comummente descritas como "próteses cognitivas" (Kapur, Gliskwy, & Wilson, 2004), teve um crescimento significativo com o apogeu da "era tecnológica", que contribuiu para o surgimento de novas "próteses", simultaneamente mais eficazes e menos exigentes para indivíduos com deterioração cognitiva progressiva, para os quais o recurso às próteses cognitivas tradicionais era muitas vezes limitado pela necessidade de Auto monitorização na sua utilização (Wilson, 2009). As "câmaras portáteis" surgem como uma proposta inovadora neste campo, embora ainda escassamente estudada quanto à sua eficácia e mecanismos cognitivos subjacentes (ver *Parte 1 – Secção 2, A critical review of the effect of wearable cameras on memory*).

A pesquisa das estratégias de RN mais eficazes com pacientes com DA em fase inicial orientou a decisão dada seleção dos métodos a implementar e a examinar na presente investigação, os quais serão descritos em seguida.

2.2.1. A elaboração do programa Memo+

A literatura sobre as estratégias internas de RN na DA recuperou métodos da reabilitação cognitiva de adultos com défices reversíveis, nomeadamente aplicando tarefas de treino cognitivo nas quais a repetição e a mobilização da memória episódica eram as principais atividades (Backman, 1992, 1996). De forma expectável, este tipo de técnicas e de treino intensivo revelou-se ineficaz com pacientes com DA, levando a um número significativo de desistências das sessões de RN (Small et al., 1997). Como resposta a este problema, neuropsicólogos de orientação clínica e cognitiva procuraram técnicas que se revelassem menos exigentes e mais apelativas para manter os pacientes na tarefa, como a aprendizagem sem erros, o desvanecimento de pistas ou a recuperação espaçada (Davis, Massman, & Doody, 2001; Lee at al., 2009). A partir da mudança introduzida com a aplicação destas técnicas começaram a surgir estudos cujos resultados revelaram a eficácia de determinadas tarefas de treino na melhoria do desempenho cognitivo, nomeadamente em provas objetivas de memória, de pacientes com DA. Contudo, na literatura estas tarefas e técnicas são apenas descritas quando ao seu uso isolado: apenas uma técnica testada num grupo de pacientes e examinado o seu efeito num domínio específico de funcionamento, por ex. recordar o nome dos colegas do centro de dia frequentado (Thivierge, Simard, Jean, & Grandmaison, 2008). Este uso isolado contribuiu para a transferência limitada dos ganhos em cada tarefa, e fraca generalização dos mesmos para o funcionamento mnésico global no dia-a-dia dos pacientes (Jean, Bergeron, Thivierge, & Simard, 2010). Meta-análises recentes sugerem que os métodos de estimulação cognitiva mais benéficos para os pacientes com DA inicial envolvem o treino multi-domínios cognitivos, dada a interdependência reconhecida entre os diferentes domínios cognitivos (Bahar-Fuchs et al. 2013; Choi & Twamley, 2013; Lim et al., 2012; Spector, Woods, & Orrel, 2008). Em resposta a esta necessidade de avaliação de um programa de múltiplas tarefas foi elaborado um programa cognitivo de treino de memória, que denominámos Memo +. O treino com este programa tem uma duração de seis semanas, num total de onze sessões, duas vezes por semana (uma hora cada sessão, tendo em conta uma aproximação ao que a literatura refere enquanto duração média de envolvimento de pacientes com DA em treino cognitivo; Bahar-Fuchs et al., 2013). As sessões deste programa foram elaboradas a partir dos princípios que Wilson e colaboradores (2009) veiculam no que respeita aos procedimentos de organização das sessões de treino cognitivo (ver *ANEXO 1- Organização das sessões Memo+*). Assim, no sentido de responder ao propósito de promoção da participação ativa e adesão terapêutica dos participantes, foi elaborada uma sessão inicial de entrevista motivacional e de psicoeducação (baseado em Miller

& Rolnick, 2009). Adicionalmente, como forma de respeitar o propósito de auxiliar os participantes a adquirem uma compreensão mais ajustada das suas limitações e dos seus pontos fortes, cada sessão integrou um momento final de feedback, dado pelo investigador ao participante sobre o seu desempenho nas tarefas dessa sessão (Sohlberg & Mateer, 2001). Foram incluídas, nas três primeiras sessões, tarefas de atenção, de modo a otimizar esta competência básica para a realização das restantes tarefas do programa (Solhberg, McLauglin, Pavese, Heidrich, & Posner, 2000). As outras sessões radicaram principalmente no treino da memória (dada a sua relevância nesta condição neurodegenerativa, o seu impacto manifesto para os pacientes e seus cuidadores, bem como a frequência com que a literatura aponta tarefas de treino cognitivo que se focam neste domínio; Clare, 2010) tendo sido selecionadas e incluídas tarefas que especificamente visassem o treino de um subdomínio mnésico específico: memória de trabalho (baseada em Netto, 2010), memória episódica visual (baseada em Cherry, Walvoord, & Hawley, 2010; Dunn & Clare, 2007), memória episódica verbal (baseada em Lee et al., 2009), memória autobiográfica (baseada em Serrano, Latorre, Gatz, & Montanes, 2004), memória prospetiva (baseada em Fish, Wilson, & Manly, 2010), memória semântica (baseada em Arkin, 2001), e memória procedimental (baseada em Zanneti et al., 2001). Em anexo é apresentada uma descrição detalhada das tarefas deste programa e das estratégias cognitivas treinadas em cada uma delas (ver *ANEXO 2 – Descrição das tarefas do programa Memo+*). A técnica de recuperação espaçada foi selecionada para ser incluída nono maior número possível de exercícios dada a consideração cada vez mais consensual na literatura de se tratar da técnica cognitiva mais eficaz para a codificação e retenção da informação em pacientes com DA (Bahar-Fuchs et al., 2013; Camp, comunicação pessoal, maio de 2012; Spector et al., 2008).

2.2.2. A utilização da SenseCam

Conforme mencionado, o apogeu dos avanços tecnológicos teve um impacto significativo nas opções de estratégias externas para auxiliar pacientes com dificuldades cognitivas. Por comparação com as primeiras próteses cognitivas estudadas na DA (agendas, pagers, calendários, diários; ver Kapur, Glisky, & Wilson, 2004, para uma revisão),), que exigiam aprendizagem para a sua utilização (e consequentemente, memorização para a sua utilização frequente, uma Auto monitorização complexa para pacientes com DA), as câmaras automáticas apareceram como recursos de fácil utilização e de baixo impacto no dia-a-dia dos seus utilizadores (Hodges et al., 2006). No momento em que foram elaborados os procedimentos a adotar na presente investigação, a única câmara automática já testada com população clínica era a SenseCam (Berry et al., 2007; Browne et al., 2011). Esta câmara, construída pela Microsoft Research Cambridge, constituiu um dispositivo portátil de captação automática de fotografias (ver Figura 1), com um conjunto de sensores incorporados (temperatura, luz, movimento) que controlam a frequência de captação, permitindo um relato visual das atividades quotidianas do seu utilizador. Trata-se de uma prótese cognitiva passiva, dada a ausência de uma intervenção consciente da parte do utilizador para a captação das imagens a serem posteriormente visualizadas e memorizadas.

Figura 1. Dispositivo Vicon Revue® (versão comercial da câmara SenseCam)

Esta prótese cognitiva foi estudada com pacientes com DA nos estudos de Lee e Dey (2008), Crete-Nishiatha et al. (2012) e Woodberry, Browne, Hodges, Watson, Kapur e Woodberry (2015). Contudo estes estudos apenas examinaram o efeito da câmara na capacidade destes pacientes recordarem informação relativa ao conteúdo explícito das imagens captadas, o que se traduz numa limitação relativamente aos objetivos deste tipo de intervenções. Assim, a ausência de uma avaliação da eficácia desta prótese cognitiva de forma sistemática em grupos de pacientes com DA justificou a seleção deste recurso enquanto estratégia externa a avaliar na presente investigação. Neste âmbito, apresentamos uma revisão crítica (ver *Parte 1 – Secção 2 – A critical review of the effect of wearable cameras on memory*) com o objetivo de aprofundar a compreensão da relevância da avaliação deste tipo de dispositivos em indivíduos com défices de memória.

2.3. Para quê?

A melhoria da funcionalidade e do bem-estar é, de um modo consensual, o objetivo último de todas as intervenções baseadas num paradigma de RN (McLellan, 1991). As intervenções não farmacológicas na DA foram desenvolvidas e disseminadas para oferecer aos pacientes, desde o estabelecimento do seu diagnóstico, uma proposta terapêutica que reduzisse o impacto desta condição neurodegenerativas no quotidiano dos mesmos (Baquero & Martin, 2015; Markwick, Zamboni, & Jager, 2012). Na literatura é referido que as intervenções de RN, aplicadas a pacientes com DA são úteis na melhoria do funcionamento de aspetos específicos da função mnésica, no maior envolvimento nas atividades de vida diária, no aumento do bem-estar emocional (normalmente examinado a respeito da sintomatologia depressiva), bem como na perceção de melhor qualidade de vida, do ponto de vista dos pacientes e dos seus cuidadores (Bahar-Fuchs et al., 2013; Clare, 2010). Deste modo, dado que, na presente investigação, procedemos a uma avaliação das intervenções que se revelam, até ao momento, como as mais promissoras e benéficas para auxiliar os pacientes com DA em fase inicial, utilizámos os indicadores de eficácia referidos. O recurso à avaliação neuropsicológica, enquanto método de avaliação da adequação da intervenção mais reconhecido, válido e estandardizado (Hampstead, Gillis, & Stringer, 2014) apresentou-se como a opção mais apropriada para averiguar os efeitos das técnicas aplicadas na presente investigação. Assim, optou-se por uma avaliação neuropsicológica compreensiva (testada parcialmente num estudo piloto com idosos saudáveis; ver *Parte 2, Secção 1 – Immediate benefits of SenseCam in neuropsychological test performance;* e utilizada integralmente nos estudos principais; *ver Parte 2, Secções 2.1, 2.2., e 3.*) cujos critérios de seleção de instrumentos radicaram nos indicadores de eficácia referidos na literatura: utilização de instrumentos que avaliassem o desempenho dos participantes relativamente a diversas componentes da memória (episódica, autobiográfica, semântica, de trabalho) e domínios cognitivos intimamente implicados na memória como a atenção e as funções executivas; avaliação da capacidade funcional no sentido de averiguar o impacto das intervenções relativamente ao nível do envolvimento adaptativo dos participantes nas atividades de vida diária; avaliação da qualidade de vida enquanto medida estandardizada de perceção global de bem-estar.

A limitação, frequentemente apontada na literatura sobre os estudos de eficácia da estimulação cognitiva na DA, decorrente da ausência de uma análise dos efeitos a longo prazo das intervenções (Huckans, Hutson, Twamley, Jak, Kaye, & Storzbach, 2010) justificou que fossem delineados, para os estudos principais, três momentos de avaliação, a saber: antes da intervenção (após cumprimento dos critérios de inclusão dos estudos pelos participantes e aceitação da participação no estudo formalizada através de consentimento informado escrito); após a intervenção (uma semana após o términus das seis semanas de duração das sessões de estimulação cognitiva); e seguimento (*follow-up*, aproximadamente seis meses depois da avaliação pós intervenção). Assim as medidas de eficácia serão consideradas quanto aos efeitos imediatos da intervenção e aos seus efeitos a longo prazo, como a literatura sugere (Wilson, 2009).

3. Breve apresentação da dissertação

A presente dissertação, reunindo um conjunto de artigos científicos já publicados ou submetidos para publicação, encontra-se organizada em duas partes principais: aa **Parte 1** inclui as publicações científicas de natureza teórica e conceptual que constituem o a fundamentação para os estudos empíricos implementados e aa **Parte 2** abrange as publicações relativas aos estudos empíricos.

Relativamente à **Parte 1**, esta divide-se em duas secções: a *Secção 1. Reabilitação Neuropsicológica* (Silva, 2016, no prelo), remete para uma descrição do estado da arte sobre as intervenções de RN desenvolvidas com população idosa, com particular foco na população com demência, estabelecendo o enquadramento para o tipo de intervenções selecionadas para análise nos estudos empíricos; a *Secção 2. A critical review of the effects of wearable cameras on memory* (Silva et al., 2016) apresenta uma revisão da literatura sobre câmaras automáticas ao serviço da estimulação da memória para contextualizar a seleção da SenseCam como uma das ferramentas de estimulação cognitiva utilizadas nesta investigação.

A respeito da **Parte 2**, aa mesma apresenta quatro secções: a *Secção 1 – Estudo 1 – Immediate benefits of SenseCam review on neuropsychological test performanc*e (Silva, Pinho, Macedo, & Moulin, 2013)) consiste na exposição de um estudo piloto realizado com idosos saudáveis, no qual a câmara SenseCam foi examinada pela primeira vez quanto aos seus efeitos no desempenho cognitivo avaliado através de instrumentos de avaliação neuropsicológica. Permitiu selecionar os instrumentos a utilizar nos estudos principais; a *Secção 2.1 – Estudo 2a – Testing the promise of new technology: The cognitive effects of wearable cameras in mild Alzheimer disease* (Silva et al., submetido) inclui os resultados obtidos em cada uma das intervenções de estimulação cognitiva aplicadas a idosos com DA inicial, considerando as medidas de avaliação cognitiva de um conjunto de testes neuropsicológicos; por seu turno, a *Secção 2.2 – Estudo 2b – It is not only memory: Effects of SenseCam on improving well-being in patients with mild Alzheimer Disease* (Silva et al., submetido) refere-se aos resultados obtidos em cada uma das intervenções de treino relativamente aos indicadores de eficácia não cognitivos, nomeadamente de incapacidade funcional, sintomatologia depressiva e qualidade de vida; por último a *Secção 3 – Estudo 3 – Mnemonic anosognosia in Alzheimer's disease is caused by a failure to transfer on-line evaluations of performance: Evidence from memory training programmes* (Silva et al., submetido) centra-se nos resultados respeitantes a medidas de metamemória (*judgments of learning*) que foram incluídas na avaliação inicial, de modo a compreender melhor o funcionamento metacognitivo dos pacientes com DA (especificamente a sua consciência relativamente ao funcionamento da sua memória), nono que respeita ao seu desempenho em exercícios de estimulação cognitiva – temática que tem suscitado um interesse crescente na investigação da memória com pacientes com DA (Shaked et al., 2014; Souchay, 2007). Dada a diversidade, ainda que complementar, dos resultados apresentados nos trabalhos que compõem esta Parte 2, a presente dissertação inclui a apresentação de uma *Discussão Integrativa* dos resultados dos vários estudos empíricos articulando-os, de forma reflexiva e crítica, com os constructos teóricos descritos nana Parte 1. Pretende-se, assim, extrair algumas conclusões relativamente às potencialidade e limites da presente investigação, aludindo a futuros estudos a desenvolver a partir dos dados presentemente obtidos.

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PARTE 1
ENQUADRAMENTO CONCEPTUAL

"The well-being of a neuron depends on its ability to communicate with other neurons. Neurons unable to connect effectively with other neurons atrophy. Useless, an abandoned neuron will die."

(Lisa Genova, citação do filme “Ainda Alice”)

1. REABILITAÇÃO NEUROPSICOLÓGICA

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1.1. Introdução

Na última década assistiu-se a um grande número de investigações sobre o envelhecimento cerebral e os seus correlatos cognitivos, que abriu novos horizontes para a intervenção como meio de reduzir o impacto negativo do envelhecimento no funcionamento cognitivo. A evidência crescente acerca da plasticidade no cérebro idoso indica que a aprendizagem continua ao longo da idade adulta avançada (IAA) e que existe um potencial considerável para modificar trajetórias de declínio cognitivo associadas ao envelhecimento saudável. Contudo, continua a existir nesta área grande dificuldade na transferência dos resultados encontrados nas investigações para o contexto do quotidiano. Há quase 20 anos, um artigo da investigadora e terapeuta Barbara Wilson intitulado "Cognitive Rehabilitation: How it is and how it might be" (1997) refletia sobre o longo caminho a percorrer para se passar de um paradigma de treino clássico de repetição de tarefas cognitivas (até atingir um nível de eficácia ótima nessas mesmas tarefas concretas), para um outro paradigma em que o indivíduo seria compreendido de forma holística e em que o treino cognitivo de competências internas seria melhorado através do treino de competências compensatórias externas, complementado ainda com treino não-cognitivo (de competências emocionais e sociais). Recentemente, a mesma investigadora referiu que, embora o paradigma de reabilitação neuropsicológica esteja disseminado junto de um maior número de indivíduos, essa difusão tem sido lenta (Wilson, 2014). Se, por um lado, essa fraca divulgação se deve à complexidade dos estudos experimentais que testam a eficácia das metodologias de abordagem reabilitativa, tal também se deve ao escasso investimento do sistema de saúde nestas intervenções, consideradas complementares às intervenções farmacológicas, tradicionalmente entendidas como a intervenção terapêutica única para a maioria das perturbações psicopatológicas na IAA (Salas & Wilson, 2014).

Uma das maiores dificuldades em definir os princípios nos quais se deverão basear as intervenções de reabilitação neuropsicológica com idosos é a diversidade ou heterogeneidade que caracteriza esta população. Enquanto alguns indivíduos são perfeitamente competentes do ponto de vista do seu funcionamento cognitivo aos 80 anos, outros debatem-se com dificuldades em manter um desempenho cognitivo ajustado aos 60 anos. Para além disso, algumas das capacidades cognitivas aparecem como preservadas ou até potenciadas com o processo de envelhecimento, enquanto outras apresentam uma diminuição da sua função (e.g., Craik & Salthouse, 2007; Park & Schwarz, 2000; Schaie & Willis, 2011). O modo como o envelhecimento afeta o funcionamento neurocognitivo do indivíduo depende de uma interação complexa de variáveis biológicas, psicológicas e ambientais, tendo as intervenções de ser orientadas para estas áreas. Numa perspetiva clínica, um dos maiores desafios com que os profissionais que trabalham com idosos se debatem é o de saber diferenciar as alterações cognitivas que são decorrentes de um processo de envelhecimento patológico das que resultam de um processo de envelhecimento saudável. Adicionalmente, esta tarefa de avaliação é dificultada pela existência de fatores moderadores e mediadores que contribuem para a variabilidade inter e intra-individual das alterações cognitivas associadas à idade.

Ao longo deste Parte focar-nos-emos nos processos de reabilitação neuropsicológica que estão adaptados para intervenções com população idosa sem défice cognitivo e naqueles adequados para processos patológicos, particularmente processos neurodegenerativos.

As intervenções de reabilitação neuropsicológica têm como objetivo auxiliar diretamente a minimização das dificuldades consideradas mais relevantes para a pessoa (e seus cuidadores) perante algum défice neuropsicológico percebido e/ou objetivo (Wilson, 2009). Num processo planeado de reabilitação neuropsicológica, os objetivos de reabilitação são estabelecidos de forma colaborativa (envolvendo todo o sistema em torno do indivíduo – família, cuidadores formais, prestadores de cuidados de saúde, etc.), e as intervenções desenhadas para atingir esses objetivos são definidas e implementadas, pelo terapeuta, no contexto da vida real do indivíduo e não apenas na situação de laboratório, gabinete ou consultório (Clare, 2008). Assim, a reabilitação neuropsicológica (RN) não é exclusivamente cognitiva – um termo alternativo e, eventualmente mais adequado, seria "reabilitação de indivíduos com problemas cognitivos" (Sohlberg & Mateer, 2001). Uma outra definição de RN é a que a considera como um sistema de atividades terapêuticas, baseado nas relações cérebro-comportamento, orientado para atingir mudanças funcionais recorrendo ao restabelecimento ou reforço de padrões de comportamento previamente aprendidos ou ao estabelecimento de novos padrões de atividade cognitiva e comportamental, com recurso a mecanismos cognitivos compensatórios (Cicerone et al., 2011). Nesta definição, o tipo de atividades terapêuticas a desenvolver num processo de RN vai depender dos objetivos da intervenção (melhoria, manutenção das funções) e do perfil neuropsicológico do indivíduo submetido a essa intervenção. Esta necessidade de personalização/individualização da RN torna complexa a sua avaliação. É neste contexto que surgem na literatura os conceitos de treino cognitivo, reabilitação cognitiva, e estimulação cognitiva, mais circunscritos e operacionalizáveis, em torno da matriz de intervenções designada RN.

O treino cognitivo envolve geralmente a prática guiada de tarefas padronizadas para melhorar ou manter uma determinada função cognitiva. A reabilitação cognitiva, entendida numa perspetiva individualizada, também envolve algumas tarefas padronizadas, mas, geralmente, dirige-se a objetivos particulares que a pessoa quer aperfeiçoar na sua vida diária e não apenas em contexto de consulta/laboratório (Grandmaison & Simard, 2003). As famílias são geralmente envolvidas ativamente no plano de reabilitação cognitiva, de modo a encontrar estratégias que cumpram os objetivos delineados pelo ou para o indivíduo. Finalmente, a estimulação cognitiva promove o envolvimento em atividades que visam a melhoria geral do funcionamento social e cognitivo, de forma a compensar défices neurocognitivos irremediáveis e a manter a função diária preservada durante o máximo tempo possível. Enquanto o conceito de reabilitação cognitiva, *strictus sensus*, pressupõe a possibilidade de retomar o nível ótimo de funcionamento ou o nível de funcionamento pré-mórbido em termos das funções cognitivas, o conceito de estimulação cognitiva é considerado cada vez que as intervenções são dirigidas à compensação ou à substituição de funções perdidas, aplicando-se, neste caso, às demências ou a qualquer doença acompanhada de défice neurológico considerado irreversível. O treino cognitivo consiste num conjunto de técnicas específicas que pode servir ambos os propósitos: reabilitação e estimulação.

Outro ponto relevante para a compreensão da RN na IAA é o seu impacto na reserva cognitiva. A reserva cognitiva permite atrasar a expressão cognitiva e funcional das doenças neurodegenerativas. Assim, a RN beneficia da identificação do grau de reserva cognitiva do paciente, permitindo a otimização das funções ainda preservadas (Stern, 2006).

Existem revisões extensas da literatura sobre o papel da RN *latus sensus* como prática padronizada para populações clínicas, como indivíduos que sofreram traumatismos crânio-encefálicos ou acidentes vasculares cerebrais (Cicerone et al., 2005, 2011). Recomendações internacionais foram emergindo no sentido do desenvolvimento de uma base sólida e clinicamente orientada destas práticas. Também na doença mental grave, as intervenções com RN têm sido alvo de interesse e de estudos controlo aleatórios (RCTs – randomized controlled trials) (cf. revisão de Kurtz, 2012). Os estudos que utilizaram a RN, ou algum dos seus conceitos subjacentes, em adultos idosos com queixas subjetivas de memória (sem défice objetivo), com Declínio Cognitivo Ligeiro (DCL), ou com demência ligeira (nomeadamente doença de Alzheimer - DA), são comparativamente mais escassos e menos esclarecedores. Contudo, algumas revisões da literatura (Bahar-Fucks, Clare & Woods, 2013a; Cotelli et al., 2012; Huckans et al., 2013; Hampstead et al., 2014; Reijnders et al., 2013; Simon et al., 2012; Stott & Spector, 2011; Woods et al., 2012) e uma meta-análise (Li et al., 2011) examinaram medidas de eficácia das intervenções de RN para potenciar o funcionamento neurocognitivo de idosos com DCL e demência (DA e vascular). Na maioria destas revisões já são incluídos RCTs, indicando, na generalidade, que estes idosos com prejuízo cognitivo beneficiam da RN. Consequentemente, têm sido definidos princípios orientadores de uma RN baseada na evidência para a IAA.

1.2. Princípios da reabilitação neuropsicológica na idade adulta avançada

O interesse crescente em implementar intervenções de RN com população idosa, com ou sem défice cognitivo objetivo, requereu uma adaptação dos princípios gerais destas práticas às particularidades comportamentais e tipos de diminuição cognitiva mais comuns nesta faixa etária. Assim, as recomendações no que respeita aos objetivos principais da RN na IAA são idênticas às de outras populações especiais. Por esse facto, podem entender-se como objetivo geral das intervenções de RN a minimização do impacto dos défices associados ao processo normal ou patológico em curso, de modo a maximizar o funcionamento diário, a segurança, independência e qualidade de vida do indivíduo. Existem objetivos específicos da RN que permitem progressivamente atingir o objetivo geral a que a RN se propõe (Haskins et al., 2012):

- Orientação para o problema, tomada de consciência e definição colaborativa de objetivos. Dar apoio ao indivíduo no reconhecimento dos problemas específicos que requerem intervenção, e colaborar com o mesmo para estabelecer objetivos significativos a curto e a longo prazo é o objetivo primário das intervenções em RN. Sempre que possível, trata-se de um processo essencialmente colaborativo, sendo valorizada a prioridade terapêutica, especialmente no início, de modo ajudar o indivíduo a envolver-se com o processo de mudança. Adicionalmente, o indivíduo necessita de ter a oportunidade de se tornar consciente dos défices/dificuldades pessoais em termos cognitivos e funcionais, o que influenciará a definição dos objetivos a longo prazo. É essencial assegurar um ambiente que forneça apoio emocional e uma relação empática. Nesta fase é importante identificar e comunicar ao indivíduo as suas áreas fortes e os seus recursos.

- Compensação e recodificação. Dotar os indivíduos das ferramentas necessárias para os ajudar a funcionar de forma eficiente, apesar dos défices persistentes ou crónicos, é o objetivo final da reabilitação cognitiva. Quando o modus operandis do indivíduo deixa de ser viável, decorrente de constrangimentos associados à doença, devem ser identificadas novas maneiras de obter os mesmos resultados. Por exemplo, o uso de um diário mnésico ou de uma agenda podem resultar numa diminuição de esquecimento de encontros marcados, apesar da manutenção dos défices cognitivos subjacentes.

- Internalização. À medida que os indivíduos aprendem a desempenhar uma tarefa ou habilidade, a prática repetida permite-lhes tornarem-se mais eficientes para compensarem os seus défices cognitivos, com menos necessidade de recorrer a apoio externo. Por exemplo, após semanas de utilização de um alarme para recordar a necessidade de consultar a agenda do dia seguinte antes de ir para a cama, este procedimento torna-se parte da rotina noturna individual, de tal modo que verificar a agenda corresponde a um comportamento iniciado automaticamente sem necessidade de ajuda externa.

- Generalização. Este é objetivo não é sempre possível. Depende das capacidades remanescentes do indivíduo em reabilitação. Trata-se do processo através do qual um indivíduo aprende a utilizar as capacidades aprendidas numa tarefa ou num contexto específico em outros contextos ou tarefas similares. Por exemplo, o uso de um diário é trabalhado para ser usado para o registo de marcações, sendo ideal que o seu uso seja transferido para outra área funcional como registar pagamentos da casa que é necessário fazer, etc.

Os objetivos gerais e específicos da RN acima mencionados (Haskins et al., 2012) compreendem todas as práticas que norteiam este tipo de paradigma terapêutico incluindo as que dizem respeito à população idosa. Os princípios gerais que devem nortear a RN são igualmente aplicáveis à população idosa. Segundo Barbara Wilson (2009), só compreendendo estes princípios é possível adaptar as práticas de reabilitação às particularidades do adulto idoso. Estes princípios (Quadro 1) foram concebidos após a avaliação da eficácia das intervenções em RN dêem várias populações alvo. Estes princípios permanecem atuais e visam auxiliar o estabelecimento de práticas reabilitativas eficazes, em indivíduos que apresentam dificuldades a nível cognitivo, comportamental, emocional e psicossocial, na sequência de um processo normal ou patológico em curso.

Quadro 1 – Princípios da reabilitação neuropsicológica (baseado em Sohlberg & Mateer, 2001)

A RN:
- Corresponde a uma prática informada a partir do diagnóstico médico e neuropsicológico, mas também baseada na formulação pelo indivíduo das suas necessidades percebidas, problemas e recursos físicos, cognitivos, emocionais e sociais;
- Requer uma aliança terapêutica prévia entre o neuropsicólogo, a pessoa alvo da intervenção, os seus familiares e outros cuidadores;
- Enfatiza a colaboração e a participação ativa da pessoa;
- Orienta-se por objetivos, foca-se no problema, partindo dos recursos da pessoa (áreas fortes/áreas preservadas) para planificar as intervenções;
- Compreende objetivos que poderão incluir quer o melhoramento das capacidades cognitivas e comportamentais ou a compensação de défices a esses níveis, quer o apoio ao indivíduo relativamente aos aspetos emocionais que prejudicam a sua funcionalidade;
- Auxilia os indivíduos a atingirem uma compreensão mais ajustada das suas limitações e recursos, bem como a compreensão das diferenças entre alterações de funcionamento consideradas normais e alterações consideradas patológicas;
- É uma abordagem eclética, dado que recorre a uma variedade de técnicas e estratégias para atingir uma otimização da funcionalidade a múltiplos níveis;
- Baseia-se numa compreensão do funcionamento prévio, incluindo capacidades, objetivos, valores, relações, papéis e padrões de comportamento;
- É responsiva às inovações teóricas e tecnológicas;
- É eminentemente multidisciplinar, pelo que oferece a vantagem de compreender o problema da pessoa com base num número diversificado de perspetivas profissionais convergentes, mas distintas.

É baseando-se nos objetivos específicos e princípios gerais da RN que se desenvolvem as recomendações e as práticas de RN na IAA. O pressuposto básico para a discussão sobre a relevância da RN na população idosa apoia-se na capacidade dos idosos para compensar vários défices de recordação episódica através de vários tipos de apoio cognitivo e contextual (Ravdin & Katzen, 2012). Numa perspetiva mais alargada, é possível identificar que as interações tarefa-idade referidas na literatura focam duas características fundamentais: 1) diferenças etárias pronunciadas a favor dos adultos jovens em tarefas de memória "não guiadas" (evocação livre, aprendizagem de pares associados, etc.) e 2) diferenças etárias reduzidas ou inexistentes em tarefas em que vários tipos de apoio contextual ou cognitivo estão presentes (evocação guiada, mnemónicas, reconhecimento, etc.). Estas observações são compatíveis com o conceito de compensação, isto é, os idosos são capazes de compensar os seus défices cognitivos/sensoriais/neurais normativos através de ajudas cognitivas e contextuais/ambientais. Assim, as práticas de RN que privilegiam a compensação são particularmente ajustadas para a intervenção na IAA.

Outro conceito da RN na IAA é o de recodificação. É sugerido que por comparação com os idosos, os adultos jovens possuem uma capacidade superior de recodificar várias vezes e de forma diferente a informação a ser recordada. Assim, a relação entre a compensação e a recodificação é direta: a necessidade de apoio contextual ou cognitivo, de modo a ter sucesso na recordação, diminui em função de uma habilidade superior de recodificação. Por outras palavras, quanto maior a capacidade de recodificar menor a necessidade de recorrer a apoio externo (pistas, organização, instruções imagéticas pelo experimentador, etc.). Assim, tendo em consideração as capacidades remanescentes do indivíduo idoso, os métodos a implementar numa intervenção de RN deverão procurar a utilização de processos que potenciam a recodificação, para além de facilitarem a compensação (Clare, 2008; Clare et al., 2003b).

É neste quadro conceptual que poderemos ler a Tabela 1, na qual são apresentados os métodos de RN mais estudados, quer em idosos saudáveis (Levine et al., 2007), quer em idosos com deterioração cognitiva (Bahar-Fucks et al., 2013; Cotelli et al., 2012; Huckans et al., 2013; Jean et al., 2010; Reijnders et al., 2013; Simon et al., 2012; Woods et al., 2012), e que se encontram divididos em função dos objetivos definidos para a RN.

Tabela 1. Objetivos e Métodos de Reabilitação Neuropsicológica (baseado em Grandmaison & Simard, 2003)

	ESTRATÉGIAS INTERNAS		ESTRATÉGIAS EXTERNAS
Objetivos	*Otimização das funções residuais*	*Substituição das funções comprometidas*	*Compensação para as funções perdidas*
Métodos	Imaginação Elaboração Semântica Auto geração de pistas Codificação integrada Processamento autorreferencial Mnemónicas	Recuperação espaçada Desvanecimento de pistas Aprendizagem sem erros	*Ajudas externas de memória:* Diários, Bloco de Notas, Listas, Calendários, Relógios-alarme, Câmaras automáticas *Apoio ambiental:* Pistas/sinais localizadores

Enquanto os métodos relativos aos objetivos de otimização das funções residuais ou da substituição das funções prejudicadas dizem respeitos às chamadas estratégias internas, os métodos que subjazem ao objetivo de compensação das funções perdidas remetem para as estratégias externas, tópicos que exploraremos em maior detalhe nas seções seguintes.

1.3. Estratégias Internas

Este tipo de estratégias, como ficou patente na Tabela 1 da secção anterior, envolve o recurso a capacidades remanescentes do indivíduo, pelo que deve ter-se em consideração o tipo de capacidades que se encontram preservadas, no momento da intervenção, para decidir a implementação deste tipo de estratégias como técnicas de treino cognitivo.

Nos princípios gerais veiculados pelas práticas mais eficazes de estimulação da memória, é proposto que a própria forma de organizar a informação transmitida ao indivíduo na explicação das técnicas de estimulação seja, já em si, uma estratégia que otimize a capacidade do indivíduo aprender: a informação deve ser dada de forma simples e concreta; a quantidade de informação transmitida de cada vez deve ser reduzida; uma mesma informação deve ser apresentada repetidamente; é proposto ao indivíduo que reproduza, pelas suas próprias palavras, o que lhe foi transmitido – Auto geração de pistas; os indivíduos devem ser encorajados a construir associações entre conteúdos similares – codificação integrada (Wilson et al., 2009).

As mnemónicas são das estratégias internas mais estudadas na estimulação da memória. As mnemónicas internas (verbais ou imagéticas) são usadas para otimizar a codificação da informação e a sua recuperação (Grandmaison & Simard, 2003). Alguns exemplos são: a construção de uma história de forma a estabelecer conexões entre palavras; a construção de acrónimos; a utilização de rimas; fixar a primeira letra de uma palavra – pista simples para facilitar a evocação de informação específica (ex. nomes). A imaginação é também usada como mnemónica para auxiliar a codificação eficaz da informação, através da criação de cenários imaginados pelo indivíduo que lhe permitam localizar a informação a reter nesse "quadro imaginado" criado (Wilson, 2009).

A aprendizagem sem erros (Baddeley et al., 2004) engloba um conjunto de estratégias mnésicas, e tem o maior número de estudos a corroborar a sua eficácia na aprendizagem de nova informação e de procedimentos em indivíduos idosos com défices cognitivos (cf. Middleton & Schwartz, 2012, para uma revisão). Trata-se de uma técnica que implica aprender a/s informação/tarefas sem cometer erros. A maioria das pessoas beneficia dos erros de aprendizagem porque se recorda deles, mas este não é o caso de um indivíduo com défices mnésicos, pois como não se recorda do erro, volta a cometê-lo, acabando este por ser reforçado, e não é capaz de o corrigir (Clare, 2008; Cicerone et al., 2005). Através da técnica de aprendizagem sem erros evita-se o reforço do comportamento de memorização incorreto.

Similar popularidade tem a técnica de recuperação espaçada ou distribuída, nomeadamente em relação aos efeitos positivos na codificação de informação em pessoas com DA (Camp, comunicação pessoal, maio de 2012). Esta técnica envolve a recordação de informação em intervalos de retenção progressivamente mais longos, de modo a promover a retenção mnésica a longo prazo.

A técnica do desvanecimento de pistas (*fading*) é muitas vezes usada de forma complementar à técnica de recuperação espaçada, sendo que as pistas para recordação da informação são progressivamente eliminadas, em intervalos cada vez mais alargados de tempo (Clare, 2008).

Os desafios inerentes à aplicação de estratégias internas na IAA encontram-se fundamentalmente relacionados com a dificuldade de estabelecer uma compreensão clara daquilo que são as capacidades cognitivas preservadas do indivíduo, devido à heterogeneidade inerente quer ao envelhecimento cognitivo saudável, quer ao envelhecimento cognitivo patológico (Wilson, 2009). Deste modo, torna-se difícil determinar se os pré-requisitos para que o indivíduo possa beneficiar destas técnicas internas de RN são cumpridos.

1.4. Estratégias externas

A complexidade na identificação das capacidades cognitivas preservadas no indivíduo idoso, o facto de algumas condições patológicas da cognição prejudicarem o recurso a essas capacidades mantidas (Martin et al., 2011), constituem uma razão para a implementação de estratégias externas em RN.

Destas estratégias externas podemos destacar, em primeiro lugar, as ajudas ambientais – como os sinalizadores de caminhos, cores diferenciadoras, telefones com atalhos visuais para elementos familiares – e as próteses mnésicas – diários, post-its, calendários, agendas, gravadores, temporizadores, entre outros (Lowenstein et al., 2004; Metzler-Baddely & Snowden, 2005; Sitzer et al., 2006; Wilson, 2009). Apesar do uso crescente destas estratégias, importa reconhecer alguns constrangimentos inerentes à sua utilização. Em particular, as próteses mnésicas tradicionais obrigam a um treino prévio organizado para que o seu uso tenha eficácia, o que pode constituir um obstáculo, nomeadamente para os indivíduos com um insight fraco das suas dificuldades (Berry et al., 2009). Numa tentativa de resposta a este problema, equipas multidisciplinares de investigadores em neurociências debruçaram-se sobre alternativas a estas próteses tradicionais, no sentido de desenvolverem procedimentos menos exigentes do ponto de vista do treino e mais eficazes quanto aos resultados obtidos. Portanto, procuraram uma resposta em que o papel do indivíduo com prejuízo cognitivo não fosse preponderante para o sucesso da intervenção (Hodges, Williams, Berry, Yzadi et al., 2006). Deste esforço sobressaem dois dispositivos: o Neuropage e o SenseCam.

O Neuropage (Hersh & Treadgold, 1994; Wilson, 2009) é um *pager* ligado através de um modem a um computador. Mensagens relativas ao que o indivíduo terá de realizar durante o dia são inseridas no computador e transmitidas para o *pager* que o indivíduo utiliza no momento apropriado. O Neuropage é considerado pelos seus utilizadores como sendo de fácil utilização, diminuindo a ansiedade face à possibilidade de esquecimento. Apesar de inicialmente ter sido estudado para compensar os défices de memória e atenção de pessoas com traumatismos cerebrais (Wilson et al., 1997), foi igualmente aplicado a idosos com DA, também estes evidenciando capacidade melhorada nas atividades de vida diária (toma da medicação e das refeições em horários adequados) (Wilson et al., 2001). Foi ainda estudada a sua eficácia para o funcionamento mais autónomo do indivíduo, sem o auxílio do cuidador, bem como para a melhoria da sua capacidade atencional, em idosos com DCL e em idosos saudáveis (Fritschy et al., 2004 para uma revisão; Wilson, 2009).

O SenseCam (Berry et al., 2009) é uma câmara pessoal portátil, cuja captura de imagens é automática. Inclui sensores de ativação automática de acordo com a temperatura, a intensidade da luz, o movimento humano que permitem um registo visual das atividades diárias do utilizador, não necessitando de treino para a sua utilização. Este dispositivo está estudado no envelhecimento cognitivo saudável (Silva et al., 2013) e na DA ligeira a moderada (Woodberry et al., 2015), tendo revelado resultados promissores relativamente à melhoria da capacidade mnésica autobiográfica (no caso das pessoas com DA) e ao funcionamento cognitivo global (no envelhecimento saudável).

A tecnologia tem assumido um papel importante na RN, nomeadamente no que diz respeito aos mecanismos compensatórios (Caprani, et al., 2006 para uma revisão). Recentemente, surgiram estudos que apontam os recursos tecnológicos como as ferramentas mais eficazes de compensação de funções cognitivas perdidas ou prejudicadas, com um impacto positivo tanto no funcionamento cognitivo como emocional dos indivíduos (Kapur et al., 2004; Sohlberg et al., 2007; Svoboda et al., 2012). É igualmente importante realçar que o impacto positivo destes recursos tecnológicos é percecionado não apenas pelos indivíduos em reabilitação, mas também pelos seus cuidadores (dado que reduzem a necessidade da intervenção do cuidador, diminuindo a sobrecarga deste).

1.5. Reabilitação cognitivas nas demências

As intervenções de RN não foram, até à data, sistematicamente testadas em todas as formas de défice cognitivo na IAA. Apesar de existir um número significativo de estudos sobre a RN no envelhecimento saudável, tem sido reduzido o esforço para analisar a eficácia da RN no DCL ou na demência ligeira. Contudo, as recomendações internacionais são claras ao considerar que os cuidados básicos para idosos com DCL ou demência devem ser potenciados com o complemento oferecido pela RN (Hyer, 2014; Woods et al., 2012). Nestas recomendações é salientado que intervenções que visam a melhoria do funcionamento cognitivo são essenciais para o impacto dos cuidados na qualidade de vida, funcionalidade e na redução de sintomas neuropsiquiátricos, principalmente no que diz respeito às fases iniciais, durante as quais é possível ainda recorrer às capacidades preservadas para compensar as capacidades perdidas (Bahar-Fucks et al., 2013a). Neste contexto, existem apenas alguns estudos experimentais da RN no DCL (Martin et al., 2011 para uma revisão), na DA e na demência vascular (Woods et al., 2012; Bahar-Fucks et al., 2013b). Outras formas de demência não têm sido alvo de estudos experimentais baseados no paradigma de RN, possivelmente devido ao seu prognóstico negativo e às complexidades relativas ao seu padrão de evolução.

Tendo em conta a abordagem holística espelhada na definição de RN, a opção por uma intervenção de reabilitação pode justificar-se para promover o bem-estar em qualquer fase da demência (Clare, 2008). Por exemplo, numa fase moderada a grave, a RN pode ter como objetivo a manutenção ou restabelecimento de capacidades básicas de alimentação, de forma a promover a autonomia, ou promover a mobilidade de modo a evitar úlceras de pressão, etc. Em fases iniciais da demência, a reabilitação pode envolver o desenvolvimento de estratégias de controlo das dificuldades mnésicas e de outros défices associados, de modo a que a pessoa se mantenha implicada em tarefas e atividades e tenha a oportunidade de continuar a dar uma contribuição válida nos contextos onde se move, havendo por isso, aqui, uma ênfase maior no domínio cognitivo. Para além disso, importa considerar as recomendações da OMS para as intervenções cognitivas e psicossociais na demência, as quais têm como finalidade que a pessoa com demência assuma um papel ativo na tomada de decisão, participação e definição dos objetivos das intervenções (Clare, 2008).

Deste modo, focar-nos-emos na reabilitação cognitiva em fases iniciais da DA, dado tratar-se da condição demencial que reúne mais estudos. As alterações cognitivas são uma característica definidora da DA e constituem um componente fundamental do funcionamento humano na vida quotidiana, afetando um vasto leque de atividades e interações, bem como a autoconsciência. O objetivo principal da intervenção na DA é o de contribuir para a preservação, o maior tempo possível, da funcionalidade quotidiana em áreas valorizadas por estes indivíduos e respetivos cuidadores, como é o caso do funcionamento cognitivo e, particularmente, as capacidades de recordar informação, compreender o discurso dos outros, manter uma conversa coerente, etc. (Martin et al., 2011).

Numa revisão sistemática da Cochrane (plataforma de estudos de meta-análise, revisões de literatura, etc.) focada na reabilitação cognitiva na DA, Bahar-Fuchs et al. (2013) identificaram resultados promissores de estudos de caso experimentais e de estudos de grupos pequenos, em áreas específicas do funcionamento cognitivo (evocação livre e guiada, imediata e diferida). Os autores mencionam apenas um RCT a testar reabilitação cognitiva individualizada na DA (Clare, 2010). Apesar de único, este estudo apresentou resultados muito positivos (os participantes consideraram-se mais competentes em termos de capacidade mnésica e que a sua qualidade de vida melhorou, sendo estes ganhos confirmado pelos cuidadores). Este RCT veio mostrar que uma metodologia, simultaneamente individualizada, abrangente e colaborativa pode ser eficaz na mudança do comportamento dos indivíduos, em particular no funcionamento quotidiano (capacidade de realizar atividades instrumentais de vida diária de forma mais autónoma – como atender e fazer chamadas, refeições simples, etc.), mudanças da perceção da autoeficácia, etc. Adicionalmente, os participantes neste RCT apresentaram alterações da ativação cerebral após a intervenção.

Assim, apesar da ausência de um número significativo de RCTs, os dados promissores extraídos deste único RCT de reabilitação cognitiva na DA e a eficácia revelada em estudos com uma dimensão da amostra modesta apontam para a justificação destas intervenções como métodos complementares da terapia farmacológica nas etapas iniciais de um processo neurodegenerativo como a DA.

Com base em vários estudos (Clare, 2008 para uma revisão) foram delineados passos essenciais a desenvolver ao aplicar um paradigma da reabilitação cognitiva na DA ligeira:

- Seleção de objetivos pessoais de reabilitação, relevantes para o quotidiano e definição de intervenções para atingir esses objetivos individuais, desenhados com recurso a métodos de reabilitação baseados em estudos empíricos, com o objetivo último de melhorar o desempenho diário, a perceção de autoeficácia e o coping;

- Desenvolvimento de intervenções que respondam aos objetivos definidos no passo anterior adotando mecanismos compensatórios e/ou restaurativos – isto é, introduzindo ou desenvolvendo o uso de ajudas mnésicas externas, mantendo ou readquirindo competências práticas previamente aprendidas e entretanto perdidas, e promover a otimização das capacidades mnésicas preservadas;
- Identificação de métodos efetivos para integrar e relembrar informação importante e, simultaneamente, dinamização de tarefas de estimulação das capacidades de atenção e concentração, de forma a responder às dificuldades cognitivas identificadas;
- Apoio ao bem-estar emocional, por exemplo através do recurso a técnicas de controlo para as variações de humor e da ansiedade;
- Envolvimento da família ou de outros cuidadores, quando disponíveis.

Apesar evidenciados benefícios observados nas intervenções, os investigadores referem que o alcance destas conclusões é limitado, dada a dificuldade de estabelecer medidas de eficácia apropriadas para avaliar os efeitos da RN no funcionamento cognitivo e comportamental dos indivíduos com DA.

1.6. Medidas de eficácia da reabilitação neuropsicológica na idade adulta

Grande parte da investigação médica tem como alvo parâmetros específicos ou doenças com um certo tipo de delimitação (ex., pressão arterial, cancro), facilitando a obtenção de medidas precisas de eficácia, que podem ser comparados diretamente entre os estudos e transpostos para a prática clínica. No entanto, o estudo da cognição é menos preciso. Assim, como não existe um único protocolo consensualmente definido para avaliar o défice cognitivo, também não existe um protocolo exclusivo para a avaliação do desempenho do indivíduo após a reabilitação cognitiva. Este é um problema real quando se pretendem comparar os resultados entre os estudos (Wilson, 2009).

Hampstead e colaboradores (2014) identificaram os tipos de medidas de eficácia de RN mais utilizadas nos estudos sobre o declínio cognitivo no idoso e apontaram as potencialidades e limites de cada tipo de medida (sumário apresentado na Tabela 2).

Tabela 2. Tipos de medidas de avaliação de eficácia mais utilizadas em RN, potencialidades e limites (baseado em Hampstead et al., 2014)

Tipo de medida	*Vantagens*	*Limites*
Neuropsicológica	- Padronizada; - Validada; - Baseada em dados normativos;	- Relevância e validade ecológica limitadas;
Autorresposta (indivíduo)	- Avalia a perceção do indivíduo alvo de intervenção; - Útil para avaliar a autoeficácia e a vontade de adotar as técnicas treinadas;	- Requer *insight* sobre dificuldades e ganhos obtidos; - Validade e fiabilidade questionáveis;
Informador externo	- Medida subjetiva, do funcionamento do indivíduo; - Útil para predizer e avaliar o *stress* e sobrecarga do cuidador;	- Suscetível a enviesamento do avaliador (humor do cuidador, efeito de recência, etc.); - Pode basear-se em inferências (o uso de estratégias internas pode ser difícil de avaliar);
Ecológica	- Traduz mais precisamente o funcionamento quotidiano; - Aumenta a probabilidade de identificar a transferência das aprendizagens realizadas; - Aumenta o envolvimento e a motivação do indivíduo.	- Número muito reduzido de instrumentos alvo de padronização ou validação; - Dificuldade em decidir os contextos ecológicos necessários e suficientes a avaliar.

Nos estudos analisados e nos quais é possível identificar as medidas de eficácia utilizadas, constata-se a presença de uma grande variabilidade no tipo de instrumentos/medidas de avaliação. É assumida a importância das medidas de eficácia das intervenções possuírem um fundamento teórico e prático bem definido (Wilson, 2009). Contudo, poucos são os estudos que fazem referência às medidas especificamente usadas e, quando o fazem, a informação disponibilizada é, frequentemente, insuficiente. O panorama destes estudos evidencia ainda a existência de múltiplas medidas de eficácia do mesmo tipo (por exemplo, testes neuropsicológicos), sendo que este aspeto acentua a preocupação com a justificação teórica dessas medidas. As medidas de natureza neuropsicológica têm sido, de forma clara, as mais comummente usadas para avaliação da eficácia da RN. O Mini Mental State Examination (Folstein, Folstein, & McHugh, 1975) foi identificado como o instrumento mais frequentemente utilizado. Facilmente se compreende que a utilidade deste instrumento é questionável dada a sua natureza não específica e potenciais efeitos de teto das pontuações em populações com défices ligeiros ou idosos saudáveis. O argumento principal para a utilização deste e de outros testes neuropsicológicos, é o de que os mesmos seriam sensíveis aos objetivos da reabilitação, uma vez que esta é dirigida aos processos cognitivos. Esta suposição não é correta, uma vez que considera apenas um domínio do programa de treino utilizado (restrito à componente cognitiva, sem abranger domínios não cognitivos) e está limitada pelas características psicométricas das próprias medidas de eficácia. Por exemplo, na tarefa de lista de palavras da Escala de Memória de Wechsler, usada enquanto medida de eficácia, é possível observar melhorias no desempenho caso os indivíduos durante o treino sejam treinados a organizar semanticamente material verbal, o mesmo não acontecendo quando o treino se dirija a capacidades atencionais e de velocidade de processamento, por exemplo (Sohlberg & Mateer, 2001). Outro exemplo: a exposição limitada no tempo a um estímulo (por exemplo, uma palavra por segundo) pode impedir o uso de estratégias internas mnemónicas, mesmo que estas tenham sido eficazmente treinadas e apreendidas. Daqui se depreendem algumas das limitações destas medidas em termos da sua relevância ecológica (Bjornebekk et al., 2010; Farias et al., 2003; Ruff, 2003). Contudo, estas limitações e, por vezes, a inadequação das medidas em função dos objetivos específicos da intervenção não significam que todos os estudos realizados não são válidos. Por exemplo, Belleville e colaboradores (2011) conseguiram, usando uma versão do teste lista de palavras da Escala de Memória de Wechsler, elucidar os mecanismos neurais subjacentes à eficácia da RN em indivíduos com DCL. Neste estudo, o treino orientado para a prática de mnemónicas e de técnicas para promoção de codificação e recuperação elaboradas, traduziu-se numa melhoria no desempenho na tarefa de evocação imediata e diferida (curto e longo prazo) da lista de palavras e numa ativação neuronal associada (lobo parietal direito inferior).

Depois dos testes neuropsicológicos, as medidas de auto-resposta e/ou com base no recurso a informadores externos são as mais usadas para testar a eficácia da RN, existindo, contudo, variabilidade nas medidas especificamente utilizadas em cada estudo. De entre as várias ferramentas de autorresposta, encontramos os instrumentos de avaliação de atividades de vida diária e funcionamento emocional, especialmente ansiedade e depressão (Brown et al, 2011; Burton et al., 2009). Embora administrada num número mais restrito de estudos, o Multifactorial Memory Questionaire (Troyer & Rich, 2002), parece constituir-se como uma medida de auto-relato especialmente promissora, dado seu foco em aspetos clínicos relevantes e a sua sensibilidade às mudanças após RN, quer em idosos saudáveis (Carretti et al., 2011), quer em idosos com DCL e DA (Kinsella et al, 2009; Troyer et al., 2008). Contudo, também estas medidas de auto-resposta apresentam limitações (dada a subjetividade que lhes é inerente), e, por isso, não devem ser usadas como medidas isoladas da eficácia de intervenções de RN.

Apesar da importância da utilização de medidas ecologicamente relevantes, apenas um terço dos estudos encontrados utilizaram este tipo de método. O seu uso limitado pode constituir mais uma razão para que a generalização dos ganhos raramente seja observada. Tem sido estudada uma medida simultaneamente ecológica e padronizada de avaliação da eficácia da RN: o Rivermead Behavior Memory Test (RBMT; Wilson et al., 1989; Wilson et al., 1998;

Wilson et al., 2008). Trata-se de um teste com validade ecológica reconhecida (Wilson et al., 1989) e as suas várias versões paralelas tornam-no atrativo para a investigação em RN. Contudo, RBMT pode ser relativamente insensível a pequenas mudanças, devido ao número limitado de itens de cada subteste, podendo propiciar a ocorrência de efeitos de teto (Wester et al., 2013). Também o teste Ecologic Memory Simulations (Stringer, 2011) avalia o funcionamento cognitivo com recurso a várias tarefas de natureza ecológica inclui várias versões altenativas, e tem evidenciado utilidade clínica após RN em amostras de pessoas com défices neurológicos (Stringer, 2011). Contudo, este teste não dispõe de estudos conhecidos com a população idosa.

Neste contexto e dado o crescente interesse na utilização de medidas válidas para justificar a pertinência da RN, o desenvolvimento de testes ecologicamente válidos torna-se uma necessidade premente. À luz destas preocupações, as recomendações veiculadas na literatura sugerem, acerca das medidas de eficácia, que (1) os pontos fortes e limitações de cada tipo de medida de eficácia sejam considerados durante a fase de desenho do programa de RN, (2) a justificação para a utilização de cada medida de eficácia seja indicada e esteja teórica e/ou funcionalmente relacionada com a abordagem de reabilitação escolhida, e (3) que sejam incluídas, sempre que possível, medidas ecológicas (Rohling et al., 2009).

1.7. Direções futuras

A variabilidade das intervenções leva à conclusão de que é imperativo constituir uma linha de investigação que permita estabelecer um apoio empírico válido para as intervenções de RN realizadas. A Figura 1, baseada em recomendações aprovadas pela American Psychological Association (APA, 2004), apresenta um modelo hierárquico que deverá nortear a definição das práticas mais eficazes em RN (Hampstead et al., 2012).

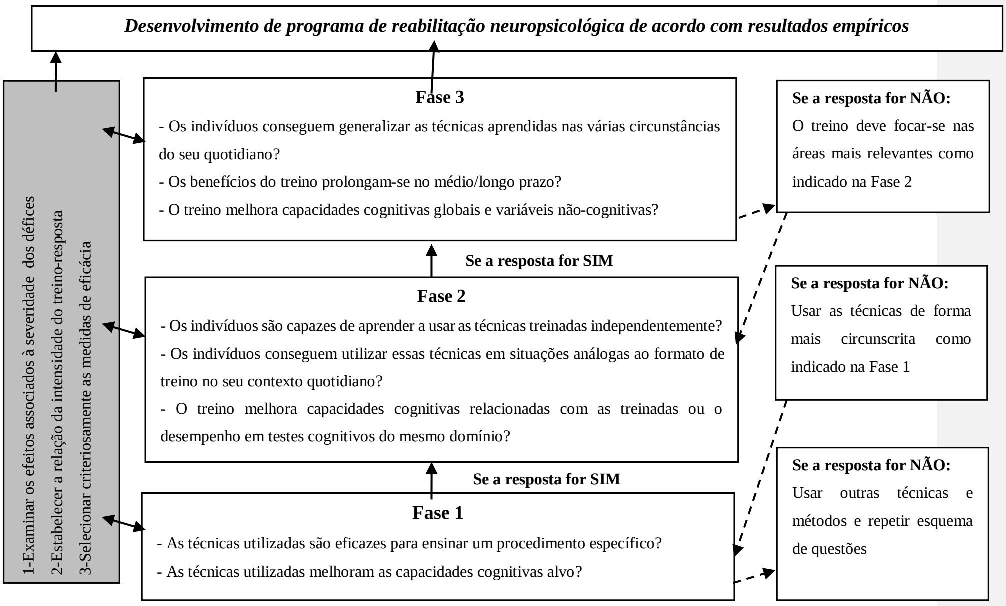

Figura 1 – Abordagem hierárquica para o estabelecimento de um suporte empírico válido para as técnicas de reabilitação neuropsicológica utilizadas (baseado em Hampstead et al., 2012)

Na primeira fase da hierarquia, a técnica utilizada no âmbito do plano de RN deve ajudar os indivíduos a aprender e a lembrar informações específicas (por exemplo, os nomes de membros específicos do grupo comunitário a que o indivíduo pertence). Se o objetivo é melhorar estratégias cognitivas específicas, a abordagem deve incrementar essas capacidades concretas e direcioná-las. A incapacidade de revelar tais benefícios básicos significa que a técnica, provavelmente, tem um valor mínimo para as pessoas com défice cognitivo e não deve ser incluída num programa de reabilitação compreensivo. A segunda fase deve indicar que os indivíduos são capazes de usar de forma independente as técnicas aprendidas em contextos semelhantes às situações de treino (por exemplo, usar a técnica de aprender os nomes de um grupo social). O insucesso nesta fase sugere que a técnica é útil apenas para estimular capacidades específicas e circunscritas, não se generalizando a sua utilização a situações semelhantes. A fase 3 requer uma mudança crítica da transição do contexto experimental para a aplicação a uma ampla gama de situações ecológicas ou capacidades cognitivas. A título exemplificativo, o treino de RN poderia começar com estímulos experimentais (por exemplo, o treino de associação de pares face-nome), depois avançar para a criação de cenários análogos a tarefas do mundo real (programas de simulação) e, finalmente, avançar para aplicação das técnicas em ambientes reais (por exemplo, o indivíduo usar a técnica na igreja, em eventos sociais e noutras situações similares). Para este esquema hierárquico poder ser adotado de modo ajustado devem ser fornecidas aos indivíduos instruções explícitas sobre a forma como podem aplicar cada técnica aprendida a outros tipos de informação, para que o processo de generalização seja reforçado. Assim, podemos dizer que as orientações futuras no que diz respeito ao planeamento das intervenções deverão nortear-se por um esquema hierárquico semelhante ao apresentado na Figura 1, de modo a que um dos objetivos últimos da RN – a generalização – seja avaliado e identificado. Este esquema poderá, assim, constituir uma abertura para o alargamento do número de RCTs. Estes permitiriam a definição clara dos parâmetros de cada plano de RN, aumentando a sua replicabilidade e, consequentemente, reforçando/validando a pertinência do seu uso na população em que foi testado.

Para além da adoção de uma abordagem metodológica mais precisa e focada nas necessidades de generalização do que se treina em RN, as orientações futuras para a intervenção nesta área deverão acompanhar os conhecimentos atualizados sobre as patologias do envelhecimento que são alvo de intervenção. Uma dessas atualizações, que pode influenciar a precocidade com que técnicas de RN são aplicadas na prática clínica, diz respeito ao conhecimento da utilização de biomarcadores das doenças neurodegenerativas. Os estudos futuros deverão incluir os biomarcadores como critérios de inclusão. Por exemplo, este procedimento seria particularmente relevante ao analisarem-se os métodos para potenciar o funcionamento ajustado na IAA em idosos que apresentam um biomarcador positivo, mas que ainda se apresentam cognitivamente assintomáticos (fase pré-clínica de uma doença neurodegenerativa). Numa revisão recente, Belleville e Bherer (2012) reportaram evidências de mudanças induzidas pelo treino cognitivo em medidas de neuroimagem, sendo também estas ferramentas cada vez mais precisas e úteis na monitorização dos ganhos funcionais do indivíduo. Devem ser realizados esforços no sentido de compreender e utilizar as potencialidades destas ferramentas novas, e dar primazia a uma abordagem multi-método de forma a facilitar o desenvolvimento e seleção das técnicas que são mais eficazes.

A partir das duas diretrizes mencionadas acima (definição de um esquema sistematizado de apoio empírico às intervenções, no sentido de promover a generalização e integração dos biomarcadores e dos dados de neuroimagem na RN) será possível comparar os estudos quanto à sua eficácia, de forma mais objetiva e válida. Estabelecida uma norma que inclua estas diretrizes, podem-se então combinar as técnicas cientificamente apoiadas em programas mais abrangentes de RN alargada, que terão como alvo as necessidades de cada idoso, a nível cognitivo, emocional e social.

Passando de uma visão estreita para uma visão alargada da RN na IAA, o futuro da RN deve incorporar princípios de saúde de prevenção primária, secundária e terciária. As orientações da RN, desenvolvidas no sentido de prevenir o declínio cerebral adquirido e otimizar as funções cognitivas, podem ser facilitadas pelos prestadores de cuidados de saúde primários. Campanhas de prevenção de quedas, programas de exercício físico, ou programas como o ACTIVE (Advanced Cognitive Training for Independent and Vital Elderly; Rebok et al., 2014 para uma atualização) são exemplos desse tipo de intervenções de prevenção primária. Por lado outro, medidas de prevenção secundária poderão constituir um desafio mais complexo, devido à dificuldade de identificar indivíduos que apresentam sintomas pré-clínicos, podendo, neste caso, os biomarcadores ser úteis no sentido de identificar grupos de idosos nos quais seja vantajosa a prevenção secundária. Um exemplo de abordagem de prevenção secundária tem sido a identificação de idosos que tiveram acidentes isquémicos transitórios e/ou sintomas pré AVC como grupo de risco a ser monitorizado e com os quais se têm implementado técnicas de treino cognitivo também usadas na prevenção primária (Unverzagt et al., 2007). As abordagens de prevenção terciária representam campos de ação críticos em RN na IAA, sendo exemplo disso o trabalho desenvolvido com recurso a intervenções cognitivo-comportamentais, dirigido a indivíduos que sofreram um AVC e que apresentam sintomatologia depressiva. Nesta situação, o objetivo passa por minimizar os efeitos colaterais associados a um episódio vascular ocorrido (Rasquin et al., 2009).

Os métodos que minimizam as limitações provocadas pelo declínio cognitivo adquirido e que compensam estas mesmas limitações são da responsabilidade dos profissionais de saúde que desenvolvem a RN (Uomoto, 2008). Assim, no futuro, através da combinação dos tipos de prevenção mencionados e das novas técnicas que estão ao dispor da RN, os idosos com alterações cognitivas, decorrentes do envelhecimento saudável ou do envelhecimento patológico, poderão beneficiar da RN como forma de melhorar as suas capacidades cognitivas, emocionais e funcionais.

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2. A CRITICAL REVIEW OF THE EFFECTS OF WEARABLE CAMERAS ON MEMORY

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Abstract

The rise of "lifelogging" in this era of rapid technological innovation has led to great interest in whether such technologies could be used to rehabilitate memory. Despite the growing number of studies using lifelogging, such as with wearable cameras, there is a lack of a theoretical framework to support its effective use. The present review focuses on the use of wearable cameras. We propose that wearable cameras can be particularly effective for memory rehabilitation if they can evoke more than a mere familiarity with previous stimuli, and reinstate previous thoughts, feelings and sensory information: recollection. Considering that, in memory impairment, self-initiated processes to reinstate previous encoding conditions are compromised, we invoke the environmental support hypothesis as a theoretical motivation. Twenty-five research studies were included in this review. We conclude that, despite the general acceptance of the value of wearable cameras as a memory rehabilitation technique, only a small number of studies have focused on recollection. We highlight a set of methodological issues that should be considered for future research, including sample size, control condition used, and critical measures of memory and other domains. We conclude by suggesting that research should focus on the theory-driven measure of efficacy described in this review, so that lifelogging technologies can contribute to memory rehabilitation in a meaningful and effective manner.

KEYWORDS: SenseCam, Lifelogging, Memory Aid, Environmental Support, Camera, Recollection

2.1. Overview

An issue of major importance for memory rehabilitation and cognitive neuroscientific theory is whether some new memory aid could retrieve memories that were otherwise inaccessible, or 'lost'. This issue has always been contentious in human memory research (e.g., Loftus & Loftus, 1980). To what extent it is possible to retrieve forgotten events is now of critical importance to the field, since a new technological challenge has arisen for memory researchers: can lifelogging technology act to aid the retrieval of autobiographical memories? (e.g. Doherty, Moulin, & Smeaton, 2011).

Lifelogging is defined as the almost constant capture of data and images from our own life for future reference. In particular the neuropsychological community has become interested in wearable cameras, such as SenseCam. In this review, we focus on human memory, and recollection more specifically, to illustrate our view that memory may be rehabilitated by providing the right cues from life-logging style technologies. There are, of course, other research and clinical applications of life-logging devices. For instance, Gemming et al. (2013) showed that the use of a wearable camera facilitated the recall of dietary behaviors, thereby reducing the under-report of calorie intake. Here we focus on the examination of what is lost from memory, and whether digital materials could ever come close to providing the perfect memory aid. There is a fundamental point here: if we watch a stream of images from our past life, are we capable of remembering it all; will it *all* cue the retrieval of the past?

To illustrate the challenges facing technological interventions for memory loss we review the use of wearable cameras in the context of a specific memory function, namely the cognitive neuroscience of recollection. In particular, the notion of environmental support is a critical issue when considering the loss of information and its possible inaccessibility. Our main argument is that though technological devices show promise in experimental settings, the nature of human memory means that we cannot assess their value in daily life without a change in the paradigm which we use to measure their benefit.

The aim of this review is to ultimately consider lifelogging's value in rehabilitation. Rehabilitation is not just about improving memory or recall. For instance, Alzheimer's patients may benefit from a deeper level of processing, or extra study time, in memory tasks, but that alone is not normally classified as rehabilitation. In rehabilitation, the concepts of transfer and generalization of gains of training to daily activities is critical. The concept of *quality of life* described by the World Health Organisation (2015) as an "individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" as an ultimate goal of neuropsychological rehabilitation is also critical to understand the extent of this type of rehabilitation.

The most critical conceptual issue in the neuropsychological rehabilitation of memory is the comparison of internal and external aids. Studies conducted with the purpose of providing effective techniques to improve performance for memory impaired patients have focused primarily on internal aids, which tend to focus on strategic control of memory (e.g., category cues, self-generation activities, errorless learning, vanishing cues, mnemonic strategies). For instance, Lalanne et al. (2015) have used a cognitive training programme to significantly improve autobiographical memory retrieval and mood in Alzheimer's disease. Such interventions are strong in terms of its theoretical background, but have showed relatively limited efficacy to stimulate people's memory in general and on a long term basis (Backman, 1992; Lustig, Shah, Seidler, & Reuter-Lorenz, 2009; Rebok, Carlson, & Langbaum, 2007). External memory aids are described as devices or mechanisms that are external to the person and that facilitate memory accessibility (Intons-Peterson & Newsome, 1992). They include personal diaries, alarms, agendas, pagers and calendars. External aids have proved efficacious for patients with traumatic brain injury (Ehlhardt et al., 2008; Wilson, 1997), but they also face several limitations: they require that the subjects are aware of their memory problems in order to be able to interact with the aids, knowing what information to record, how and when to access that information (Grandmaison & Simard, 2003). For its use to be effective, each aid requires training so the user can benefit from the device, which can be an obstacle (Lee & Dey, 2008). Altogether, both internal and external strategies have several problems, mainly concerning the fact that they require the subject's awareness and input, which is often compromised in memory impairment. That is, to benefit from keeping a daily journal, for instance, one must remember to both write the journal in the first place, and to consult it at the appropriate time. If we return to the definition at the beginning of this section, there is also the issue of transfer and quality of life. Lifelogging technologies perhaps offer a more passive form of rehabilitation tool – since intelligent systems can compensate for problems in awareness, and constant ongoing monitoring can overcome the need for carers to select and filter information on-line during the use of an external aid. We return to this issue later.

2.2. Memory loss and recollection

Our understanding of memory impairment has been greatly enhanced by our knowledge of the human memory system; and in particular the fractionation of long-term memory into different types based on both biological and psychological considerations. Possibly the most important distinction is between episodic and semantic memory (e.g. Tulving, 2002). The most commonly experienced form of memory loss is from episodic memory (Baddeley, 2001). This form of memory is particularly difficult to rehabilitate since it is by definition, personal and based on the *recollection* of our own past episodes and experiences, retrieved with a sense of 'mental time travel' (Tulving, 2004).

There are two issues here, both of which are critical to our argument. First, unlike language information and general knowledge (semantic memory), there is no shared basis for the vast part of episodic memory – it can be easy to re-learn facts which exist in the public domain, such as *David Cameron is the prime minister of the UK* – but it is far less easy to train someone on their personal past since it will be idiosyncratic to that one person, and perhaps not even recorded. Second, episodic memories are retrieved with a particular experiential characteristic: that of 'remembering'. Whereas we might learn again significant dates and recognize acquaintances with some rehabilitation technique or other, with episodic memory, we might never re-experience them in the same rich evocative way which is central to episodic memory and specifically, recollection. Finally, the role of recollection is captured in the difference between actively *recalling* and passively *recognizing* something. Recall is disproportionately impaired in many memory disorders, and is also more reliant on recollection processes (Mandler, 1980, 2008; Souchay & Moulin, 2009; Yonelinas & Levy, 2002).

Episodic memory, despite being difficult to rehabilitate, is also the form of retrieval which resonates with lay conceptions of 'memory', easily evoked by looking at our old diaries, reading journals, or looking at old photographs of family and friends. Unsurprisingly, researchers such as Bourgeois (1990, 1992) and Sohlberg and Mateer (1989, 2001) have used such materials to try and ameliorate memory loss in Alzheimer's disease (AD). For example, Bourgeois focused on evaluating the efficacy of "memory wallets" (which included photographs of people and relevant occasions) to improve the ability of making factual statements and the conversational skills of patients with moderate AD, and benefits were found at a 6-weeks follow up in the number of events described, a finding that was then replicated by others (Hoerster, Hickey, & Bourgeois, 2001; McPherson et al., 2001; Yasuda, Kuwabara, Kuwahara, Abe, & Tetsutani, 2009). Solhberg and Mateer (1989) trained patients to keep a personal diary/memory notebook and found that this reduced repetitive discourse (findings also described by Donaghy & Williams, 1996). Despite these findings that photographs and personal diaries are useful for patients with memory impairment, it is noted that there was no focus specifically in episodic memory, and it is not clear whether these kinds of aids enable the patients to re-experience forgotten events.

For wearable cameras, we are interested in recollection, since it is the focus on the retrieval of 'something more' rather than the mere assessment of prior occurrence (Moulin, Souchay, and Morris (2013)). This is a particularly important point when considering the effects of re-presenting a previously encountered stimulus to a person with memory difficulties. We are interested in how such a recognition prompt may promote *recall* of associated information. It is this process of recollection which we are targeting, since otherwise we are only considering the passive and relatively limited retrieval of something which is already identified in a stimulus. In turn, when we consider recollection we also emphasize the personal experience of the information to be recollected (Piolino, Desgranges, & Eustache, 2009), and this is proposed to be the 'mental time travel' system responsible for our self-identity (James, 1890). Thus, the rehabilitation of memory, in our view, encompass a strong episodic character, and the goal must be to focus not only in the ability to recognise a specific and meaningful personal event, located in time and space, but also the ability to travel back into the past and relieve specific details of that event distinguishing it from any similar one. According to this argument we should see the rehabilitation of memory as reinstating recollection of a prior event. Of course, there is a long tradition of memory improvement through repeated recall and retrieval practice (e.g. Sumowski et al., 2014; and see Wilson & Glisky, 2009 for a full discussion), and we are not claiming wearable cameras would replace these techniques, but possibly offer new materials to be used with such techniques, rather than verbal materials, for instance.

2.3. The environmental support hypothesis

Our focus on recollection and rehabilitation means that we need to consider how the overlap between cues at encoding and retrieval may lead to autonoetic remembering (Nairne, 2002). A critical issue is the extent to which cues (such as a diary or images provided by a wearable camera) can support the retrieval of information from memory. We are already discounting the idea that lifelogging could replace episodic remembering, since our recollection hypothesis above, suggests that episodic memory is never just about 'facts' but about experiences (this is an idea which resonates with the philosophical and phenomenological debate about episodic memory; see (Dokic, 2014)). Of course, we think it may be useful to have procedures and external stores of information which can be re-accessed, but for the purposes of rehabilitation of episodic memory, if we do not reproduce the core phenomenology of episodic memory we have not improved episodic function, but compensated for it.

We suggest that to understand how the input of external information can enervate the memory system, and support rather than replace retrieval we can draw upon the environmental support hypothesis. Craik (1986) made the assumption that the key for retrieval success is an interaction between external support (environmental) and internal, self-initiated processes. As such, in episodic memory impairment, the execution of self-initiated processing is compromised (Craik & Byrd, 1982), and more extended environmental support is required to retrieve the information. For example, someone with Alzheimer's disease may not be able to recall a given item from a list of words, but can nonetheless recognize it, when shown it, or recall it with the right prompt. For this reason, when an adequate and strong environmental support is provided at retrieval, people with memory problems are more able to retrieve information, but when there is less support from external stimulation, they fail to provide answers based on re-experience of events and instead provide judgments based on familiarity (Backman & Small, 1998; Bialystok, Craik, & Luk, 2008). Tulving and Arbuckle (1966) make a distinction between the information stored in memory that is available and the information that is accessible, because they consider that intact memory traces of information without the appropriate recall conditions are available in memory storage, but are not accessible for retrieval. This again suggests that people with memory impairment fail to find otherwise intact traces in storage, not necessarily because the information is not there, but because it is not accessible. Nelson (1978) showed that there were enduring consequences of information in memory. Even if a piece of information had been forgotten, it was possible to measure the effects of previously having had that information in memory using tests of interference.

Neuroscientifically, we suggest that environmental support acts to stimulate the critical medial temporal lobe memory system, when self-initiated frontal contributions are weak – and there is the failure to set up adequate cues for retrieval (e.g. Moscovitch and Behrmann (1994)). That is, external information acts to excite the memory networks which through a process of spreading activation lead to the retrieval of associated information. At such point the network of neurons (presumably through Hebbian associations) becomes large and self-sustaining, and we may experience a rich and evocative form of episodic memory, i.e. recollection. Our hypothesis is that the retrieval of personal information through wearable cameras should necessarily invoke the rich evocative recollection of the self in the past. The environmental support provided by lifelogging images will operate to stimulate remaining neural networks, and should, if activation is sufficient, access other associated information in memory. Therefore, the result of 'self-in-the-past' cues will reinstate remembering, not just the passive decision, *yes, that was me, I was there*. We are not arguing, however, that wearable cameras are the only means to access such information, and other internal and external memory aids would have the same goal.

2.4. The state of art: SenseCam and other wearable cameras

Hodges et al. (2006) first developed SenseCam, a wearable camera that takes still images (and which does not record sound) according to triggers from sensors, as a 'retrospective memory aid'. SenseCam is a lifelogging device where the images are taken passively, which means that the user has no intervention in the action of taking photographs of the events. Additionally, as it is worn around the neck it creates images from the point of view of its user. According to Muhlert, Milton, Butler, Kapur, and Zeman (2010) the automatic capture of images is of great ecological value because no intentional encoding is required for information that will later be showed and tested at retrieval.

SenseCam has a fish-eye lens in order to maximize the field of view, and it either takes one picture every 30 seconds by default, or it takes pictures according to its set of sensors (light, temperature, sound, movement) – in practice this means it takes several pictures per minute. A display to see photos is not included in the device, meaning a computer is required to upload the images and display them later. SenseCam was built by Microsoft Research Cambridge and its first commercial appearance was as the Vicon Revue®, manufactured by OMG PLC and then developed into the Autographer® which also had GPS and Bluetooth capability. Both of these devices are no longer commercially available, but Narrative Clip (http://getnarrative.com/), a similar, smaller, wearable camera is available. All of these devices are based on the same principle of a wearable camera that takes still images passively and automatically, in order to provide a rich set of photos of a person's daily activities (Doherty et al., 2011). Here we use the generic term "wearable camera" to apply to all such devices, using the term 'SenseCam more specifically for issues related only to that one device. In this field we can also find mobile applications that include functions similar to these wearable cameras, such as the One Day app (https://www.oneday.com/), an application that instantly creates short videos allowing the user to include music and a theme to organize their videos of important events. However in this case, the possibility to create videos without the users' input is not available.

2.5. How wearable cameras work: The 'something more' hypothesis

The aim of this article is to review wearable cameras in the context of our view of recollection and the environmental support hypothesis. Our hypothesis is represented in Figure 1. We have established that brain disease or damage presumably can leave information in memory networks active but inaccessible. We suggest that wearable cameras provide cues which can raise activation above threshold and increase accessibility. The review of lifelogging images, where a whole day can be compressed into a 'movie' sequence of still images, should have a beneficial effect on episodic memory. The critical point is that reviewing such images should not act merely on an assessment of prior occurrence ('*yes, I was there'*, or even '*I must have been there*') but it increases access to the 'something more' of recollection.

According to our view, if wearable cameras are to be anything more than merely a device which takes photos for later review (i.e. like any other camera), it has to work on information not readily available in the images itself. This is in part related to issues around the transfer effect in rehabilitation: it would be good if review of images from wearable cameras improved performance in ways that went beyond just the images themselves. We would also hope that wearable cameras can act to reinstate previous thoughts, feelings and sensory information not in the images themselves. We are not the first to suggest this idea. Loveday and Conway (2011) suggest that the SenseCam works by giving viewers 'Proustian Moments':

A ''Proustian moment'' (PM) is a moment of intense recollection when images of the past flood into consciousness, and the rememberer has a powerful experience of recollection. Such moments have an almost ''aha!'' quality to them and may often feature the recall of highly specific details that were not available previously and, in some cases, were not previously known.

Loveday and Conway (2011), p. 697-698

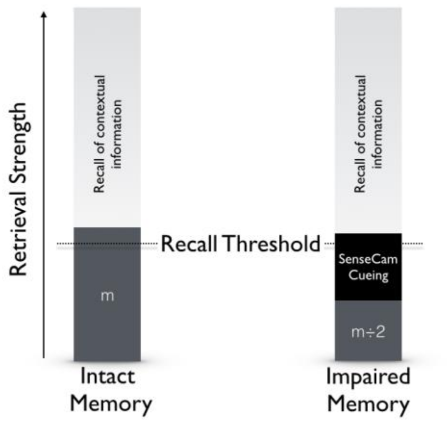

Figure 1. The effect of SenseCam review.

In memory impairment, activation strength of memories (*m*) is reduced to below the threshold of recall. SenseCam review increases retrieval strength through cueing of contextual details from original event, achieving supra threshold activation of recognition memory; recall of contextual details is now possible

Other authors had also previously described such recall of details after being cued by the images (Berry et al., 2007; Browne et al., 2011). In keeping with the environmental support hypothesis, Loveday and Conway (2011) propose that the SenseCam helps reinstate memories that are not currently accessible. They suggest that events in long term memory are ‘never lost’ until the neural networks in which they are represented ‘decay’ or become unstable. That is, information can be unavailable for recall until cued effectively, and events can lie below threshold in memory. This is illustrated in the left-most column of Figure 1. We show a memory strength of *m*, based on the level of activation of neural networks that represent a given event. Where activation is below threshold, we may retain a memory of the event, but not be able to recall it. Cueing may energize the neural networks to reach a point where additional information can be retrieved, labeled 'recall of contextual information'. This information is bound to the event knowledge and rests in the same neural networks, but is not directly represented in the images themselves.

The right hand bar represents how review of images from a wearable camera may act on a weakened memory trace (*m*/2). Our hypothesis is that wearable cameras act as a powerful cue to raise the activation of the event above threshold, and like any other cue, it will make information and detail available to the experient, even if it is not represented in the images. This is Loveday and Conway's Proustian Moment: the image cues access to information we may have thought forgotten or unavailable. The critical point for us is that, unless lifelogging technologies can generate such a Proustian effect, it is rather unimpressive: the alternative is that it merely re-familiarizes participants with scenes. Thus, in the rest of this review, we focus on what evidence there may be that wearable cameras act to give back recollection of prior events, and that it therefore transfers to other meaningful domains, thoughts and general wellbeing.

2.6. A review of wearable cameras in the memory literature

Here we present a review of the extant wearable camera literature, outlining research that illustrates the broad use of this device to understand memory and how it can be enhanced. The databases used for this search were *Pubmed, ISI Web of Knowledge* and *ScienceDirect,* and we also identified studies by reference tracing and through citations. The search terms were "*wearable camera*", "*SenseCam*", "*memory*", and "*lifelogging*". From the databases described we initially found 92 papers that included two or more of these search terms in the title, whose abstracts were screened. We included the 25 papers for this review after screening the abstract according to the following criteria: SenseCam or its similar devices must have been used in the experiment and not only referred to (the wearable camera should have been used as the main material of the experiment); the purpose of using wearable cameras in the studies should be memory-related and/or with rehabilitation purposes (i.e. we excluded studies that used SenseCam to analyze physical activity/lifestyle, teaching/education profiles, reflection/culture). (For a practical overview of the uses of SenseCam see Doherty et al. (2013).) Also, selected articles described experiments with results and not methodologies, opinions or editorials and theory statements. (To date, there have been two special issues on SenseCam (Memory Volume 19 issue 7, 2011 and American Journal of Preventative Medicine, Volume 44, Issue 3, 2013).) All studies described in this paper used the experimental or commercial versions of SenseCam (Vicon Revue), none of them used the more recent wearable cameras (Autographer or Narrative Clip).

From the twenty-five papers selected (see Table 1), eleven papers describe case studies, most of them representing the first attempts to rehabilitate memory with SenseCam (Berry et al., 2009a; Berry et al., 2007). Patients are reported with limbic encephalitis (Berry et al., 2009a), medial temporal lobe damage (Bowen, 2008), acquired brain injury (Brindley et al., 2011), mild cognitive impairment (Browne et al., 2011), brain tumour (Pauly-Takacs et al., 2011), hypoxic ischemic encephalopathy (Garrood, 2012), Alzheimer's disease (Piazek et al., 2012) and Korsakoff's syndrome (Svanberg & Evans, 2014). Compared to a personal diary or to a baseline condition, SenseCam improved retrieval of events depicted in the images (Berry et al., 2007, 2009; Brindley et al., 2011; Browne et al., 2011; Pauly-Takacs et al., 2011). SenseCam was also described in these studies as improving the specificity of recall, i.e., the events were described in more detail after viewing SenseCam images (Doherty et al., 2009; Brindley et al., 2011). The authors are not clear whether the extra detail was immediately apparent from the images reviewed, but in general we can cautiously suggest that the extra detail retrieved is in line with an effect of recollection attributed to SenseCam review. One of these studies placed emphasis on an increase in specificity for events *not depicted* in the images (Loveday & Conway, 2011) – which is critical for our hypothesis.

This issue of retrieval of events not depicted in the images is a critical one, and has been a theme in many of the case studies since the earliest examinations of SenseCam in memory impaired groups (e.g. Browne et al., 2011; see also Woodberry et al., 2015). It is neatly summed up by a quote from Berry et al. (2007, p. 597), describing one of their patients: "Mrs B reported that seeing the beginning of a clip brought the images 'flooding back' without necessarily having to view further images, suggesting that she was remembering the event itself rather than the movie clip, something that was confirmed by Mr B, who said that his wife was able to recall details of events not depicted in the images." A priority for research is to examine these types of experiences in more detail with designs which explicitly test the quality and quantity of non-depicted images which can be retrieved.

From this set of case studies, two experiments point to an enhancement of memory which is not episodic in nature. Both Pauly-Takacs et al. (2011) and Garrood (2010) suggest that the beneficial effect of wearable cameras in their patients is due to a change in personal semantic information. For instance, Pauly-Takacs et al. presented facts during a tour of campus with their patient. He was able to retrieve the given facts when presented the relevant image: *'Longest corridor in Europe. I have been there'*. This suggests that people can re-learn information as knowledge, which is registered in the semantic system. Perhaps more worryingly, there was also a tendency for this semantic memory to over-extend to inappropriate cues, in the form of false memories. Pauly-Takacs et al. note that their patient would regularize any picture with distinctive architectural columns in it to having been a place he had visited on the basis of having learned from his own SenseCam images that he had visited a place on campus with salient columns.

A further set of studies was also based on single group experimental designs in healthy and clinical populations. Naturally, the use of inferential statistics is a strong point of group studies, although the sample sizes range from 3 to 144 participants. Again, these studies reinforce the idea that wearable cameras improve both episodic memory and personal knowledge. Many of these studies measured the amount of information retrieved following review (quantity), but some also asked participants to give subjective evaluations of their memory (quality) – a measure critical for our hypothesis. Studies found both improvements in the quantity and quality of information after wearable camera image review, with more details retrieved about the events and more specific judgments about event boundaries, for instance. This was true of both for healthy (Doherty et al., 2010; Kalnikaite et al., 2010; Sas, 2013) and memory impaired populations (Lee & Dey, 2008, Crete-Nishihata et al., 2012, Woodberry et al., 2014).

Within this category, Sellen et al. (2007) perhaps provide the clearest test of our recollection hypothesis, in that they measure the phenomenological experience of remembering (i.e. recollection) and knowing of events. Sellen et al. tested 19 undergraduates who wore wearable cameras and carried out recognition memory tests across 13 consecutive days. They ran a yoked design whereby the photos from another person's camera served as a control condition. They tested memory in three different ways: a self/other condition ("was this image one of your own?"), an ordering test where they had to put their images from a day in order, and a recall test where they generated details and events from the day. Most importantly, this recall test examined the effect of free recall of events before and after reviewing just 10 of their own (or yoked control) images. For this free recall of events, they were asked to classify their memory for the events according to Tulving's remember/know (R/K) distinction.

Sellen et al. report a number of interesting findings, not least, that merely wearing a SenseCam significantly improves memory for that day's events (i.e. without reviewing the images). Importantly, image review lead to a significantly higher number of remembered events from the SenseCam days, and also it appeared to improve retention for the events when tested after a delay of 10 days. Fewer events were known than remembered in general. When participants reviewed their images, there was no main effect of review on 'knowing', although there was the suggestion that SenseCam review acted to maintain the knowledge of events over time. The ordering task provides a somewhat more objective measure, where we can compare the real order with the participants' response. This showed a large effect of image review, but it is an unusual measure: participants are better at ordering the events in their own day than someone else's. Such unorthodox measures point to some of the methodological challenges of working with wearable cameras which we discuss below. With their recognition test, the task is similarly difficult to interpret, since it is a judgment about whether the image represents one's own day, or someone else's. Interestingly, there were false positives: people did misinterpret others days as their own, but in general, participants could significantly discriminate their images from other people's (80% of the time). Several other studies report that participant's own images are significantly more powerful cues than others' images, or than pictures from their own life taken by others (Doherty & Smeaton, 2010; M. Lee & Dey, 2008; St Jacques & Schacter, 2013).

In summary, the Sellen et al. article – notably the recall results – offer some support for the idea that wearable camera images (just ten of them, in fact) help people retrieve events from their day: an extra two events on average are retrieved as a consequence of SenseCam review. There appears to be no effect on personal semantics, however, or the 'knowledge' of events. However, within this set of articles, there are other studies which suggest an improvement in personal semantics, and the improvement in this semantic memory appears to prevail for longer periods of time, compared to the decay in memory for specific events (Doherty & Smeaton, 2010; Finley et al., 2011).

These studies also examine whether wearable cameras are different from other kinds of recording devices, which is critical for both the marketability of SenseCam and its status as a rehabilitation device (compared to for instance, a standard digital camera, or an audio recorder). For example, Sellen and collaborators (2007) concluded that the passive capture provided by the SenseCam automaticity is better than the active capture that regular cameras offer (because this active capture will influence the way moments/events are experienced). Moreover, Hodges et al., 2011 suggested that SenseCam might deliver such a powerful effect because it takes so many images: the chances of any one image cueing a memory are higher. Researchers have also combined visual information given by SenseCam with locational data (GPS), now available in the Autographer device (OMG®) (Kalnikaité et al., 2010). Kalnikaité et al. concluded that locational and visual data together are better that visual data alone at cueing memories, but that visual data alone is more useful for recollection (true recall obtained by the number of remember judgments divided by the number of events recalled) than locational data alone. This suggests that the more information wearable cameras can give people about the past, the more powerful they will be as memory aids.

However, two studies within this set showed more negative results. Seamon and collaborators (2014) showed that use of SenseCam did not help to improve recognition for atypical actions performed during a walk. Using a tour of a museum, St Jacques and Schacter (2013) showed that despite SenseCam helping to improve the quality of the judgments about reviewed images, it also improved false recognition (distortions) between own images and related novel images. These two studies were conducted with decent sample sizes (see Table) of healthy participants, and both included a planned walk with events to perform or to see.

An important set of the studies identified in the Table 1 are those that present neuroimaging data. This again could speak to our hypothesis about activation of the memory network as a result of image review, since the neuroanatomical location of recollection has been shown to be the medial temporal lobe (see Moulin, Souchay & Morris, 2013 for a review). Imaging studies (fMRI during recognition judgments), show that viewing images from wearable cameras increases cortical activation in the short term, and indeed, in the medial temporal lobes. For instance, review of images activated the right anterior and posterior parahippocampal regions (Milton, Muhlert, Butler, Smith, et al., 2011). In long term retention, SenseCam evoked a set of areas in the neocortex (medial prefrontal cortex) and not the medial temporal lobes. One can add to this data a set of conclusion brought by other experimental design (two groups), where St Jacques and colleagues (2011) compared the impact of SenseCam in both males and females cortical activation in short term, and here medial temporal lobes activation was also present but more for males, whereas females activated regions of prefrontal cortex, that was previously associated to long term retention. As females are known to present generally better autobiographical memory than males (e.g. Bloise & Johnson, 2007), and the data gathered here highlight that long term improved recollection is more due to prefrontal cortex than medial temporal lobes, one may, therefore, suggest that these regions are activated by SenseCam to stimulate stronger and longer memories (St Jacques et al., 2011).

In another study using wearable cameras to analyze cortical activity for own versus other images (St Jacques, Conway, Lowder, & Cabeza, 2011), we can also consider another unique characteristic of SenseCam over other methods of memory improvement. The purpose of wearable cameras is to capture self-referent information, and this study shows that the self-projection provided by SenseCam activated the ventral medial pre-frontal cortex (*mPFC*), an area that contributes to the medial temporal lobe (MTL) network linked to memory processes, thus energizing this network to a level where is possible to re-experience the personal past, allowing the retrieval of both information depicted in the images, the related contextual information, and the autonoetic consciousness, critical for recollection success, as proposed by Loveday & Conway (2011).

The last two studies presented in the Table used between group comparisons, aiming to study, the effects of age (Silva et al., 2013) and the effects of transient epileptic amnesia (Muhlert et al., 2010) on memory performance after being presented SenseCam, Diary and Verbal materials. Silva and colleagues (2013) attempted to study the effect of wearable cameras in stimulating memory in general, not testing the memory for information depicted in images, but instead testing general memory performance, assessed through standardized cognitive tests. This study is the first, and so far only, to use outcome measures that are not related to the content of the training with SenseCam. The results were again in agreement with our hypothesis, as all the memory measures used (e.g., Autobiographical Memory Test, California Verbal Learning Test-II, Digit Span, Month Ordering) showed improved performance after three days wearing SenseCam and reviewing its pictures, compared to a condition of keeping a diary for the same amount of time. There was no examination of the memory for information captured by the camera versus the information written in the diary, and so this supports our view that wearable cameras might provide a general boost in memory networks, 'something more' than only cueing recall for information in the images.

For the clinical study that compared patients with Transient Epileptic Amnesia with matched controls (Muhlert et al., 2010), the information gathered makes less of a contribution to understanding the role of SenseCam to improve recollection. The patients, as expected, showed accelerated forgetting both for information captured with wearable cameras and for verbal stimuli, but no comparison of the differences between the amount of forgetting for SenseCam pictures versus word lists was made. Thus, no information was provided to examine potential differences between SenseCam and verbal cues for recall and forgetting, which is critical to understand the value of wearable cameras in these patients. However, Mulhert et al. do point to the utility of wearable cameras in measuring issues such as forgetting in real world contexts.

In summary, across these articles, there appears to be a clear benefit of review of images from wearable cameras on both recall and recognition. The studies however are heterogeneous as regards methods and populations, and there are some studies reporting null findings, and others which provoke some interesting questions. Even though there appears to be a clear benefit of reviewing images, for instance, there was one study that also gave a clear benefit of just wearing SenseCam (without even reviewing the images). We might therefore imagine that using a technology such as wearable cameras – at least in the short term – changes how people act and encode events in real life.

2.7. Methodological reflections

Here we address a few methodological issues of importance. One issue which we do not cover here are the ethical challenges associated with capturing and storing a large number of images, many of which are personal but are captured in the public domain. For an article on this topic see Kelly et al. (2013).

There are a meaningful number of studies in the literature after 2006 that used wearable cameras for memory related purposes, with both healthy and memory impaired populations. However, with the exception of a small number of studies (Seamon et al., 2014; St Jacques et al., 2011, 2013; Silva et al., 2013; Muhlert et al., 2010) these were mostly single case studies (mostly with no control group) or group studies with small groups of subjects ($n < 20$). Thus, the support for our hypothesis, at this stage, is statistically limited. A further weakness is that several of the articles reviewed were conference proceedings on SenseCam where the involvement of peer-review is not clear. This reflects the differences in publication habits amongst computer scientists and software engineers, and cognitive scientists and clinicians. The reference to studies which themselves had not been presented in any great experimental detail is also critical. For example, one interesting study (Doherty et al., 2010, reported in Doherty et al., 2012) concerned autobiographical memory using a recollection (remember/familiar) methodology for CG, a healthy male who at the time of testing had worn a SenseCam everyday for two and a half years and was tested on his memory for 29,301 personal events taken from his store of 2,579,455 SenseCam images. This study is reported second-hand in multiple places, but no original article presenting the case in detail appears. CG was tested on "who, where, what" questions (cf. Perfect, Mayes, Downes, & Van Eijk, 1996), when reviewing 50 events randomly chosen from his large collection, as well as making remember and familiar judgements. For these 50 events, he reported recollecting only 14% of events (which was supported by his ability to answer who, where, and what questions). The aims of this study are very close to our aim of knowing – in real life – what can be retrieved from memory, and suggests that, at least in healthy groups, the extra recollection enabled by lifelogging technologies is actually rather modest. Clearly, however, such a fundamental issue warrants more than a single case design reported briefly in conference proceedings.

Seamon and colleagues used a between subjects design to analyze if wearable cameras were more helpful than a diary or no memory aid to improve recall of atypical actions that participants had performed one week earlier (long term delay) (Seamon et al., 2014). However, one major limitation of this study for our hypothesis is that both the outcome measure (written recall one week after having reviewed the images) and the material used (atypical actions) are very much different from the way clinicians and cognitive researchers would use wearable cameras in rehabilitation. Their procedure is that participants review images directly after encoding, but not during or immediately before the final test (so the retrieval conditions are sub-optimal – there is no environmental support at time of retrieval). Thus, we think that their high-powered study might be thought of merely as a test of whether wearable cameras aid the consolidation of memories shortly after their formation – and their null findings suggest they do not. This is a valuable finding for our understanding of how wearable cameras might work: they do not appear to consolidate memories if used shortly after the initial encoding. However, this methodology cannot address the impact of wearable cameras in recollection, nor does it speak to rehabilitation. We do not suppose that having worn a wearable camera at an earlier date, someone would choose *not* to use it when trying at a later point to retrieve the details of the previous experience. That is, in this study, review of images was not carried out at the final retrieval test in either the SenseCam or control condition.

In memory rehabilitation research there is a need for ecological validity. Most of the studies in this review used dependent variables which were not useful for measuring generalization, nor recollection. One commonly used measure was the recall percentages of particular events (some chosen by the caregiver) (Berry et al., 2007, 2009; Lee & Dey, 2008; Doherty et al., 2012; Brindley et al., 2011; Browne et al., 2011). Others used self report scales (Crete-Nishihata et al., 2012; St Jacques et al., 2011; Svanberg & Evans, 2014). Nearly all of the dependent variables concerned retrieval of information directly related to, and possibly depicted in the images themselves. In these studies, there is another issue: it is difficult to differentiate between genuine recall and information that is depicted in the images themselves or inferred from them (or indeed inferred from general knowledge). For example, when reviewing an image people can make sense of their life with statements such as: "I am walking to Spanish or German class. I know this because the tree angle is very dramatic and it wouldn't be at noon. Which is when I'd normally leave this area." Finley et al., 2011, p.10). In this example, there is little evidence that the participant has produced a Proustian Moment, or has re-accessed their personal past in a way which indicates recollection.

In other case studies, where more detailed information was retrieved by the participant, (Doherty et al., 2010; Pauly-Takacs et al., 2011), it was not limited to episodic information, with several authors pointing to the fact that wearable cameras improve personal semantics. This points to a general effect of wearable cameras that goes beyond cueing of information in the episodic system, and along with 'inferencing' suggests that wearable cameras are responsible for supporting more than just the recognition of pictures. Perhaps the clearest illustration of a general effect of wearable camera use is shown by Silva et al., 2013, who were not interested in what came to mind as people reviewed images, but their cognitive performance after review. They used general neuropsychological tests to test the efficacy of SenseCam over a diary in general cognitive performance. On the one hand, this is positive: because the effect of wearable cameras may transfer to other domains and tasks; but the negative interpretation of such results is that wearing or using a wearable camera somehow stimulates cognitive function more generally, and this could even just be due to the positive emotional consequences of using a device which was fun or novel.

Although the goal of many of the studies has been rehabilitation, they lack a measure of quality of life and of functional capacity that could contribute to understanding the impact in daily life of lifelogging methods, as highlighted by Wilson and Glisky (2009) in the definition of neuropsychological rehabilitation as a paradigm aimed to provide *"the best chance of reducing everyday problems and enhancing independent living and quality of life for the majority of those with organic memory deficits"* (p.20). Some studies used a set of subjective ratings such as vividness and mood, but they were not found to be useful to analyze the efficacy of wearable cameras over other kinds of training, mostly due to the short-term assessment in which they were used (Loveday & Conway, 2011; Svanberg & Evans, 2014; Silva et al., 2013). It could be that like errorless learning, the best way forward is to match the approach to the goals of the person receiving rehabilitation. Errorless learning is an internal rehabilitation procedure which works well in memory impairment (for reviews see Clare & Jones, 2008; Middleton & Schwartz, 2012), but to have benefits for social function which may improve the wellbeing of our patients, the procedure needs to be tailored to suitable materials (re-learning the names of friends and club members, for instance (Clare, Wilson, Carter, Roth, & Hodges, 2002; Thivierge, Simard, Jean, & Grandmaison, 2008). For such a system to work, we thus need to have not only a mnemonic technique, but also a certain degree of user and carer input to tailor the materials to the patient.

Our belief is that the best method to assess a new technology to rehabilitate memory is to have an informed approach that takes on board the neuroscientific basis of memory. However, to meet the criteria of memory rehabilitation, and not just memory 'improvement', there must be clear links to real-world behaviors and functions. In fact, the use of errorless learning has developed in exactly this manner – from a theory-driven technique derived from experimentation, to something that can now be adapted to a person's needs and difficulties.

For wearable cameras, we stress that the choice of control condition is a critical methodological issue when considering transfer to self-relevant materials. We note that several of the reviewed studies used a recognition test based on a Self/Other paradigm (Pauly-Takacs et al., 2011; Sellen et al., 2007; St Jacques & Schacter, 2013) where the question is, *did this happen to me*? Or, *is this one of my pictures*? For our recollection hypothesis, and for generalizability, we want to know if wearable camera image review promotes re-experiencing of previous events. A test which just asks if the image is from the self or other does not assess the 'Proustian Moment'. In daily life we rarely think of an event or meet a person and ask ourselves, *was it me who met this person, or someone else*? Thus the use of completely novel images from another person's life, seems to be an unsuitable set of control images. On the other hand, suppose we take as control images a set of plausible images, like a close friend or partner's images or those of a student at the same University. They will frequent the same places and have the same friends, and may even attend the same events. As such, we would expect there to be some effect of reviewing others' images in recalling their own experiences. In sum, we suggest that vast differences in the images between the test and control conditions render the test too easy; but having an overlap between the two conditions may lead to genuine cueing and memory effects as shown in several of the reviewed articles (e.g. in the museum tour study, there was cueing effects from non-visited locations; St Jacques & Schacter, 2013).

For our recollection hypothesis, aside of asking people about their experiential state, the critical test is of recall and not recognition. However, many studies tested only recognition and not recall (Milton, Muhlert, Butler, Benattayallah, & Zeman, 2011b; Milton, Muhlert, Butler, Smith, et al., 2011; Pauly-Takacs et al., 2011; St Jacques & Schacter, 2013). Even those studies which did assess subjective experience in recollection overlooked the category critical for recollection: Know and Familiar judgments (but without Remember) judgments were taken by Berry et al. (2009). Sometimes only subjective measures were taken, in the form of ratings, so we do not know if extra information was retrieved, or whether there was only a 'sensation' of retrieval (Piasek et al., 2012; St Jacques et al., 2011; Svanberg & Evans, 2014).

The use of immediate recall or very short term recall limits the conclusions we can make about the efficacy of wearable cameras, because in daily life we would want to look at long term effects. Recall was tested immediately or in the short-term in two of our reviewed studies (Garrood, 2010; Sas et al., 2013). On the other hand, a too long delay between review of images and test is also not reflective of real-world use of wearable cameras; presumably you would watch the film at the moment you wanted to remember what had happened. Recall was tested after a long delay between review and test in one of the studies reviewed here (Seamon et al., 2014).

Arguably, if we wish to make claims about the efficacy of wearable cameras in memory rehabilitation, then we should follow a medical style, randomized placebo controlled clinical trial. However, using a 'placebo' method is difficult with such a technology, and instead it seems ethically and experimentally critical to settle on a suitable control condition. This is not a problem which is unique to wearable camera research. Many recent studies have investigated the introduction of robotic devices into the field of stroke rehabilitation, for instance (Chang & Kim, 2013). Like with lifelogging, both ethical and methodological constraints hinder the design of double-blind randomized controlled studies of robot-assisted therapy. In the absence of such methods, meta-analysis is desirable, with a consideration of effect sizes. After the steady accumulation of data in wearable camera experiments this will be a priority – although there is insufficient homogenous data at this point. Chang and Kim argue that where there are methodological issues in evaluating the efficacy of a technique (in their case robotic rehabilitation of motor capacities) then theory-driven approaches are critical.

2.8. Conclusions

To conclude, a number of research groups using different methods and populations have indicated the value of SenseCam as a memory rehabilitation technique. Our goal was to bring together these early studies into a coherent whole, and provide a theoretical basis for any improvement in memory from the use of wearable cameras. We argued that the ideal test of the efficacy of wearable cameras is that it should enable the recall of 'something more'. This hypothesis has a sound basis in how we think about episodic memory – and the capacity to 'recollect' our personal past. A small proportion of the articles reviewed here also focused on this 'remembering' component of memory. At the moment, the evidence for this special action of wearable cameras is weak, though positive, and future research efforts should focus on this particular theory-driven measure of the device's efficacy. A further issue related to this, might be to better understand whether, and how wearable cameras differ from standard cameras in memory improvement. This would be a relatively simple idea to test. The theory is that wearable cameras in some way mimic human memory, by giving a visual input of time slices which are temporally ordered, and which offer a first person perspective. Reviewing the sequence of ‘snapshots’ is proposed to emulate the retrieval from episodic memory (Hodges et al., 2011). This would mean that wearable cameras are superior to devices which do not share these features.

We also stress that the multidisciplinary nature of research thus far has left a gap between an appropriate theoretical basis to sustain the use and effectiveness of wearable cameras and the rapid innovation of these devices. For memory rehabilitation specialists, however, wearable cameras may represent another tool that can be used to help alleviate memory impairment. As well as the cognitive effects of these devices, and the theoretical basis of their function, we also need to consider more the motivations for using such devices (for more on the motivations to use lifelogging see Caprani et al., 2014). It is also critical to think not just about cognition, but transfer to other domains such as the self and identity. (For more on this issue in Alzheimer’s disease and in relation to lifelogging, see Piasek et al., 2015.) Since it is a rather non-invasive technology which can be used passively, it is unlikely to be harmful. For the longer term, research efforts need to concentrate on the rapid, efficient and meaningful retrieval of appropriate images from large databases of personal information, and a robust evidence base for the ‘something more’ hypothesis needs to be generated

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Table 1. Summary of experiments using SenseCam for memory-related purposes.

Papers are organized in this table according to the type of study, then by publication year and type of sample (controls, clinical)

Authors	Type of study	Sample	Method	Results
(Berry et al., 2007)	Case study	63-year old female with limbic encephalitis (Patient "Mrs B")	Within-subject design 3 Conditions: Baseline, Written Diary, SenseCam for recording interesting events Free recall before and after SenseCam review Follow-up 1, 2 and 3 months after	80% of events recalled after SenseCam condition, superior to Diary (49%) and Baseline (2%) Recall cued by SenseCam was maintained at follow up (67% after 2 months, 76% after 3 months)
(Berry et al., 2009b)	Case study	66-year old female with limbic encephalitis (Patient "Mrs B")	Within subject design 4 conditions: No review; SenseCam review; (holiday trip); written diary (holiday trip); Novel images (other person's SenseCam images) fMRI at retrieval –"Known/Familiar/Not known" to stimulus from all conditions	More Known and Familiar responses in SenseCam condition than the other conditions (p<.01) SenseCam viewing: increase in cortical activation.
(Bowen, 2008)	Case study	36-year old female with MTL (medial temporal lobe) damage and severe anterograde amnesia (Patient "Mrs CB")	Within subjects design 3 conditions for an event of playing a board game: SenseCam; Audio recording; No recording Immediate and delayed recall Specificity of event recall assessed	Long delay contributed to lower recall scores in three conditions (p<.01) No effect of SenseCam for free recall (p=n.s), but superior cued recall when asked general questions compared to baseline (p=.01; SenseCam mean= 3; baseline=2.1)
(Doherty et al., 2012)	Case study	34-year old Healthy adult male, "CG"	Remember/Familiar judgments for set of SenseCam picture from 2,5 years SenseCam usage	Only 14% of fifty events randomly chosen from collection of images were recollected
(Brindley, Bateman, & Gracey, 2011)	Case study	28-year old man with Acquired Brain Injury and anxiety disorder (Patient "Mr A")	Within subject design 3 conditions: SenseCam, Diary, No aid Only recorded anxiety triggering events	Mean of 94% events recalled after SenseCam, compared to 39%(Diary) and 22% (no aid) Higher specificity of emotional information recall in SenseCam

Table 1 (continued)

AUTHORS	TYPE OF STUDY	SAMPLE	METHOD	RESULTS
(Svanberg & Evans, 2014)	Case study	51 year-old female with Korsakoff's syndrome (Patient "Ms A")	SenseCam record of one activity a week and reviewing every day (eight weeks period) Daily monitoring with Self report scale (memory, mood and identity), no objective measures	Subjective improvement of memory for events and for self-identity (rates increased 4.36). Not significant improvement of mood (.78 change from baseline).
(Sellen et al., 2007)	Single Group experimental design	19 healthy young adults (10 male, 9 female, age range 18-22)	Within subjects design 3 variables - SenseCam vs Control; - Passive vs Active capture; - Short and long interval memory test Free and delayed recall,; R(Remember)/K(Know)/G(Guess) judgments, Yes/No recognition	Increased number of events recalled for SenseCam days compared to control (before - p<.02 - and after seeing the images - p<.03) Know judgments are improved over time (p<.08) in SenseCam Passive capture is better than Active capture
(Doherty & Smeaton, 2010)	Single Group experimental design	3 healthy adult males	Review own SenseCam images from random daily life (one month) and mark boundaries between all events Repetition after 1 and 2 years respectively	Boundaries are better judged by the person who lived the event Decay of event boundary with passage of time (1/2 years)
(Kalnikaité, Sellen, Whittaker, & Kirk, 2010)	Single Group experimental design	18 healthy adults (4 female, 14 male, age range 25-56)	Within subjects design 2 conditions: SenseCam images plus GPS for two weeks; No memory aid SenseCam review 5 weeks after events (Only images; Images plus GPS; GPS only) Recall after memory questions assessed. Remember/know/guess test	Detailed recall superior for GPS plus SenseCam (.<.01). SenseCam images alone no better than recall with no memory aid (p>.05). True recall superior for SenseCam alone better than GPS or GPS plus SenseCam for true recall (p.<.01) ("Remberer" events divided by number of events recalled)
(Finley, Brewer, & Benjamin, 2011)	Single Group experimental design	12 healthy young adults (4 males and 8 females)	Within subject design SenseCam usage during 5 days, pictures taken by fixed intervals or by sensors, pictures reviewed in two nights Recognition ratings and image cued-recall (1,3 and 8 weeks after)	Both recall and recognition higher for reviewed days (Recall M=50.55; Recognitin=3.55) than for non reviewed days (Recall M=45.51; Recognition=3.25) Decline in memory performance across time intervals

Table 1 (continued)

Authors	Type of study	Sample	Method	Results
(Milton, Muhlert, Butler, Benattayallah, & Zeman, 2011a; Milton, Muhlert, Butler, Smith, et al., 2011)	Single group experimental design	15 healthy young adults (8 male, 7 female, age range 18-25)	SenseCam usage for 2 days Remember/know judgments and strong/weak recollective judgments collected fMRI during retrieval Study repeated at a 5 months interval with 10 participants	Recollection elicits no activation in the MTL at a 5-month delay; after a 5-month retrieval delay greater posterior parahippocampal gyrus (pPHG) activation for familiarity than recollection memory; Remote recollection recruits a number of extra-MTL regions
(Sas et al., 2013)	Single group experimental design	14 healthy young adults (7 males, 7 females, age range 18-23)	SenseCam and Sensewear usage for 6 hours Data inserted in AffectCam system with both SenseCam sensors and Sensewear arousal information End-of-the-day 4 high and 4 low arousal photos viewing to prompt recall	Emotional arousal increased the recall of detail for events ($p<.01$) Event itself, place and associated emotions are better recalled than events time and thoughts ($p<.01$) using SenseCam in high or low arousal pictures
(Seamon et al., 2014)	Single group experimental design	144 healthy young adults (age range 17-23)	Between subjects design 3 conditions: SenseCam, Diary, No aid (during a walk where atypical actions were performed) After walk, groups divided in social or individual reminiscence reviewing conditions; Review occurs one week before free recall	Social reminiscence better than self-reminiscence (proportion means .78 vs .64), Recall of the atypical actions with SenseCam images (.74) or diary entries (.69) was not better than no aid (.68).
(St Jacques & Schacter, 2013)	Single group experimental design	Study 1: 42 healthy young adults (15 male, 27 female (age mean=21,1) Study 2: 41 healthy young adults (18 male, 25 female, age mean=21,41)	Study 1: Self-guided museum tour wearing SenseCam 48h delay review with novel (but related) images, yes/no recognition and confidence Order of image presentation manipulated (chronological vs random) Study 2: Same procedure, different manipulation Perspective of pictures (self vs other) presentation manipulated	Higher recognition for the images corresponding to own experience ($p<.01$) than for others images False recognition increased for novel images ($p<.01$) Enhancement of memories but also distortion, false alarms more influence by prior experience than hits ($p<.01$).

Table 1 (continued)

Authors	Type of study	Sample	Method	Results
(M. Lee & Dey, 2008)	Single clinical group experimental design	3 older adults with Alzheimer Disease	Within-subjects design Personally significant experience wearing SenseCam during two weeks, audio recorder, and GPS. 4 conditions: Control (no aid), Patient wears camera, Caregiver wears camera, and Caregiver wears and selects images	Self-guided condition increased recall of details (aprox. 40%of details recalled), compared to caregiver conditions ($p<.05$), where there was a decrease in performance (aprox. 10%).
(Crete-Nishihata et al., 2012)	Single clinical group experimental design	5 older adults with early AD or MCI	SenseCam usage during 3 personal outings accompanied by a study partner; After each outing engagement in a 2 -week evaluation, interview five times with Autobiographical Interview (AI). 3 months after each event, conduction of a follow-up with AI	Review of SenseCam images improved episodic recall for personal events over time (in 4 of 5 participants)($p<.05$). Subjective experience: SenseCam reexperience was more effective at cueing memories because of the greater number of images
(Woodberry et al., 2014)	Single clinical group experimental design	6 older adults with Mild to Moderate Alzheimer disease (age range 64–84)	Every two days for two weeks each patient's memory for an event was assessed, followed by a structured review of the SenseCam images. Longer-term recall was tested one and three months later. A written diary control condition followed th.e same procedure	SenseCam review method resulted in significantly more details of an event being recalled over two weeks ($p<.01$). 3 months post event, 4/5 patients (one drop-out) recalled significantly more details of events in the SenseCam condition while the other patient showed no difference.
(St Jacques, Conway, & Cabeza, 2011)	Two groups experimental design	12 healthy females and 11 healthy males (age range 18-35)	Within subjects design SenseCam usage and diary records for 6 days fMRI scanning one day after SenseCam and verbal cues viewing and subjective ratings recorded	Higher subjective ratings of vividness, reliving, importance, emotion and uniqueness for SenseCam cues ($p<.01$). fMRI patterns stronger for males than females; greater activity in left hippocampus, retrosplenial cortex, left inferior frontal gyrus, and right occipital cortex with SenseCam review (for high 'reliving' ratings)

Table 1. (continued)

Authors	Type of study	Sample	Method	Results
(Silva, Pinho, Macedo, & Moulin, 2013)	Two-group experimental design	15 healthy adults and 14 healthy older adults	Within subjects design SenseCam usage for 3 days Diary writing for 3 days Neuropsychological testing after each condition (order counterbalanced, parallel forms of tests)	Higher performance in most neuropsychological tests after SenseCam usage and viewing for both age groups (ex. Autobiographical Memory Test, $p<.01$, Effect size .82) Larger effects for memory and executive function tasks
(Muhlert et al., 2010)	Two-group experimental design clinical versus control	Eleven patients with Transient Epileptic Amnesia and eleven matched healthy controls	SenseCam usage during a cultural visit Memory for images of events in the same day, 1 and 3 weeks later Forgetting compared to forgetting of a word list and with performance in procedural memory task	Accelerated forgetting in TEA: (i) affects memory for real-life events as well as laboratory stimuli; (ii) is maximal over the first day compared to controls ($p.<05$); and (iii) is specific to declarative memories, procedural memory being intact in comparison.

PARTE 2

ESTUDOS EMPÍRICOS

"Whatever you do will be insignificant,

but it is very important that you do it."

(Mahatma Gandhi)

1. Estudo 1 - Immediate benefits of Sensecam review on neuropsychological test performance

Publicado em: Silva, A., Pinho, S., Macedo, L. and Moulin, C. (2013). Benefits of SenseCam review on neuropsychological test performance. *American Journal of Preventive Medicine*, 44(3), 302–307.

Abstract

Background: One of the core applications of SenseCam is memory rehabilitation. Research has shown that it is an effective memory aid which can cue episodic memories. However, the extent to which SenseCam might improve aspects of memory beyond merely re-presenting forgotten events and locations has not been assessed.

Purpose: In line with neuroimaging and anecdotal reports, this study aimed to investigate the hypothesis that SenseCam review would enhance cognitive function more generally.

Methods: Participants were 15 healthy younger adults and 14 healthy older adults who wore a SenseCam for three days, and wrote a diary for another three days (control). In each of these conditions, participants completed a comprehensive neuropsychological battery immediately following review of the pictures or reading of the diary. Data for this study was collected from October to December 2011 and analyzed from January to March 2012.

Results: Both young and older adults showed higher performance on most measures used in this study immediately following SenseCam review. Effects were largest for memory and executive function tasks, whereas speed of processing was not affected.

Conclusions: SenseCam review seems to act as a cognitive stimulant in the short term, with significantly higher neuropsychological assessment scores following SenseCam review compared to re-reading a diary.

1.1. Introduction

The beginning of this century was characterized by a change in the field of cognitive enhancement strategies, with growing interest in compensatory techniques – external memory aids. These techniques - personal diaries, agendas, timers, check-lists - described as memory prosthetics,[1] proved to be effective for improving everyday memory function in people with memory deficits.[2] However, these aids required a training period, which was considered an obstacle for those individuals who deny their memory difficulties[3]. SenseCam[4], a wearable camera developed by Microsoft Research Cambridge, is a recent addition to the external aids available for memory rehabilitation. It automatically records pictures of the user's activities which can be reviewed later, with no need for training.

The first clinical studies with SenseCam suggested significant improvement in autobiographical memory (memory for recent episodes captured on the device) in amnesia[4]. In brief, SenseCam generates powerful cues which aid remembering and helps the retrieval of episodic information related to the reviewed images.[5,6,7,8] SenseCam review improves retrieval of autobiographical information even after time intervals of two to six months, suggesting maintenance over long periods.[5,9] Some studies in healthy adults have aimed to understand the processes underlying this effect.[10,11] These initial explanations consider that SenseCam pictures mimic episodic memory[12] because these pictures evoke visual experience, are from an egocentric viewpoint, correspond to reality and make summary records, thus contributing to a stronger memory trace.

SenseCam has therefore been shown to be efficacious in autobiographical memory (mostly visual data), and personal semantic memory,[13] and for events and images contained in the SenseCam images. In this study, the purpose was to examine how SenseCam may stimulate memory more generally. There are no comprehensive studies conducted with SenseCam as a memory aid that involve a detailed neuropsychological assessment following its use. One impression gained from on anecdotal reports from patients, is that SenseCam might operate to stimulate memory function more generally, for domains and materials beyond those merely captured in the images reviewed. In this study this hypothesis is tested by giving participants a thorough neuropsychological assessment after reviewing SenseCam movies of their daily life, and comparing it – in the same participants – to neuropsychological assessment following re-reading a diary. Groups of younger and older adults were used to examine how this hypothesis may stand up to group differences in memory function. I.e., the focus of this study is whether SenseCam review improves performance on a series of standardised cognitive tests.

1.2. Methods

A total of 29 participants completed the study. In the young adults group (n=15) the average age was 19 (SD 1.9), where 65% were female; in the older adults group (n=14), the average age was 75 (SD 5.6) and there were the same number of males and females. In both groups the mean years' of education was 13 years (SD 2.2). The sample size was dictated by the length of time each participant could have a SenseCam, and the availability of SenseCams in the laboratory; to foreshadow the results, the experiment was suitably powered.

The young adults were recruited through a participant pool scheme running in the Psychology Department at the University of Leeds. In the case of the older adults' recruitment, they were also selected from an Older Adults Voluntary Participant Pool at the University of Leeds. This panel is composed of medically fit volunteers who have previously been screened and excluded if they have cognitive function scores below normal cut offs. Participants were included only if they were native English speakers. All study procedures were approved by the research ethics board of the department. No participants withdrew from the study. All participants provided informed consent and accepted to use SenseCam and the diary for three days each. Participants were informed from the beginning of the sessions that after the end of the experiment all the images captured with SenseCam would be provided on a CD, and the diary returned.

In this study a mixed design was used, with age as the grouping variable (between subjects' factor) and memory aid as a within subjects' factor (all participants used the two memory aids tested in this experiment). The SenseCam review condition was compared to a written diary (a common memory aid used as control task). The design was factorial, and the results were yielded to a series of ANOVAs. Data were collected by one of the authors (ARS) in individual test sessions.

Participants wore the SenseCam and were instructed, before starting to use it, how to charge it and how to use the buttons (privacy, on/off button, manual trigger). They were instructed to wear the camera for as long as possible each day, but to remove the camera for any events which they wanted to remain private. All participants produced three days' worth of images to review. After three days, they returned to the Institute of Psychological Sciences at Leeds (IPS) and their pictures were downloaded and imported into SenseCam Image Viewer software[4]. For the diary, participants wrote a page-by-day journal, noting the events that they had experienced over three days. They were instructed to record events in the corresponding day's page as soon as possible after their occurrence but without letting the diary influence the persons' regular behaviour. The diaries were not scored, but each participant complied with the instructions given and produced at least four descriptions of personal events for each day. After three days with the diary, participants returned to IPS and were asked to read in the session the information they wrote in the diary. Because the emphasis was on the act of review on unrelated neuropsychological tasks we did not analyse or classify the content of people's diaries and SenseCam movies.

Crucially, participants used one of the memory aids (SenseCam or diary) in a counterbalanced fashion for three days and returned for an individual session of neuropsychological assessment. In the assessment session, participants firstly reviewed the contents of their memory aid, and then a comprehensive neuropsychological assessment followed immediately. In terms of review, for the SenseCam condition the participants were shown the pictures captured by the device over the three days. In the diary condition the participants were presented with the pages of the diary that they wrote during the three days.

A battery of neuropsychological tasks (Table 1) was selected on the basis that they had alternate forms; i.e. it was possible to use them meaningfully at two time points. The neuropsychological tests given were: California Verbal Learning Test – II (CVLT; [14]); Month ordering (MO[15]); verbal fluency test (VF[16]); Symbol Search and Coding (SSC[17]); Autobiographical Memory Test (AMT[18]); Digit Span task (DST[19]). These tests are routinely used by psychologists in clinical settings for cognitive assessment. Older adults were screened for dementia using the Addenbrooke's Cognitive Examination – Revised[20]. We also asked participants to evaluate their memory and the use of the two memory aids by administering a multiple choice questionnaire. In this questionnaire, participants were asked to rate their memory (on a scale) after using SenseCam or the diary. They rated the

Comentado [S1]: o que quer dizer este expoente, uma vez que não se trata de nota de rodapé?

Trata-se das referências bibçliográficas?

Comentado [ARS2R1]: Sim professor, o expoente diz respeito Às referências, foi o que a revista pediu, para colocar as referências deste modo. Devo uniformizar?

impact of watching the memory aids to prompt more memories, and several feelings following review of the diary and SenseCam images: surprise, excitement, alertness, and emotional impact. They also rated the sense that the memory aid was helpful to remember forgotten information; and the experience of reliving the events. These ratings were all given on a 6-points scale. We yielded the results to a series of ANOVAs for the comparation of the two memory aids.

Table 1. Neurophsychological tasks

California Verbal Learning test – II (CVLT [14]).	Participants are asked to memorise a 15 item list, which is repeatedly presented and tested across 5 trials. There are measures of recall and recognition. This is a classic measure of verbal episodic memory.
Month ordering (MO[15]).	Participants hear a set of months, and they have to memorise them and organise them into the right order, before repeating them to the experimenter. This is a test of working memory.
Verbal fluency test (VF[16])	Participants are asked to produce as many words as possible beginning with a given letter (F,A,S) or category (animals, occupations) in a minute. This is a test of executive function.
Symbol Search and Coding (SSC[17])	Participants are given a symbol to detect amongst an array of similar symbols. The time taken to detect and cancel each symbol is measured (Symbol search). Participants also re-code a sequence of symbols using a given number code (symbol coding). These are measures of the speed of processing.
Autobiographical Memory Test (AMT[18])	Participants retrieve information from their on life cued by words, such as 'dog', 'happy'. The experimenter rates the specificity of the memories generated according to a standardised scale.
Digit Span task (DST[19])	Participants are presented with a sequence of digits which they must memorise and then repeat immediately to the examiner, either in the same order (digits forward) or the reverse order (digits backward)

Comentado [S3]: idem

nesse caso, não seria necessário repetir a referência bibliográfica

Comentado [ARS4R3]: Apenas mantive assim porque como se trata de um artigo já publicado não posso fazer alterações à sua publicação. Mas se a professora considerar de forma diferente, informe-me por favor para eu fazer as alterações necessárias.

1.3. Results

All analyses were performed in IBM SPSS v19. The critical comparison was whether neuropsychological test performance was higher following SenseCam review compared to re-reading the diary (see Table 2). The two age groups were also compared. The strategy was the same for each of the separate neuropsychological test scores; to compare test performance in a 2 x 2 (age group x memory aid) ANOVA. For conciseness, we focus here on describing the main effects of memory aid (but see full ANOVA terms in Table 2 for completeness). Table 2 presents the F-ratios and partial eta square as effect size (for the main effect of memory aid only). Most measures show a statistically significant higher performance in the SenseCam condition (tasks that tested verbal memory, semantic memory, working memory and executive functions). Only two measures yielded a non-significant main effect of memory aid ($p > 0.05$): the speed of processing measures (Symbol Search/Coding). In most of the tests the younger adults also have significantly superior performance than the older adults, as is usual in the memory literature.[21] There was only one significant interaction found, for the Autobiographic Memory Test task, whereby older adults had more improvement than the younger group with SenseCam ($F(27)= 9.213$, $p<0.001$, $\varepsilon^2 = 0.25$). However, the effects of SenseCam review were parallel in the two groups. This interaction was examined using paired samples t-tests to examine whether each group showed a significant effect of SenseCam review, in line with our key hypothesis. This analysis revealed significant effects in both the young ($t(14)=8.071$, $p<0.01$) and older adult ($t(13)=8.090$, $p<0.01$) groups.

Table 2. Neuropsychological assessment, by age group and memory aid

Cognitive test[a]	Older Adults SenseCam Mean (SD)	Older Adults Diary Mean (SD)	Younger Adults SenseCam Mean (SD)	Younger Adults Diary Mean (SD)	Main effect of memory aid (F statistic) df =1.27	Main effect of age group (F statistic)	Interaction effect memory aid x group (F statistic)	Memory Aid Effect size, ε^2
AMT	19.07 (1.38)	12.57 (3.81)	19.22 (1.15)	15.99 (3.33)	127.05*	6.327*	9.213* ε^2- 0.25	0.82
CVLT (immediate)	13.99 (2.26)	12.43 (2.03)	15.07 (1.34)	13.80 (1.01)	17.22*	5.729*	.020	0.29
CVLT (short delay)	12.64 (3.27)	10.64 (3.20)	14.33 (1.63)	12.33 (2.02)	19.31*	3.906*	.001	0.42
CVLT (long delay)	13.14 (2.79)	11.36 (2.87)	14.80 (1.02)	12.13 (1.64)	37.38*	4.464*	1.363	0.58
CVLT (recognition)	14.86 (1.51)	13.29 (3.02)	15.73 (0.46)	15.01 (1.01)	9.102*	6.433*	2.214	0.25
Month ordering	14.07 (1.14)	12.36 (1.98)	14.53 (0.99)	13.53 (1.06)	22.92*	3.964*	1.587	0.46
Digit Span	21.64 (2.87)	19.64 (4.44)	20.27 (2.91)	17.87 (3.09)	25.99*	3.785*	.215	0.49
Phonemic fluency	59.42 (11.9)	52.00 (14.07)	53.00 (12.2)	44.13 (10.68)	21.04*	3.965*	.202	0.43
Semantic fluency	39.85 (6.53)	34.50 (7.59)	38.13 (3.40)	34.53 (4.42)	32.76*	3.186*	1.261	0.55
Symbol Search	26.71 (6.09)	29.07 (7.22)	43.27 (3.43)	41.93 (3.90)	0.266	73.270*	2.456	.01
Coding	57.29 (9.19)	59.21 (11.3)	91.13 (10.8)	89.20 (8.80)	0.000	91.123*	1.277	.00

[a] For all the standardized measures used to test participants' cognitive function, a higher score corresponds to a better performance in the test.

* significance ≤ 0.05 – the mean results of the variables analyzed are statistically different.

AMT, Autobiographic Memory Test; CVLT, California Verbal Learning Test

The subjective experience of the memory aids might begin to explain the mechanisms behind these findings (see Table 3 for data). Interestingly, the subjective data are in line with the objective data collected, with SenseCam review rated as prompting more memories than the diary. SenseCam use also led to significantly higher reports of surprise and alertness compared to the diary review. In all, both groups agreed that SenseCam was a more exciting memory aid to work with, more helpful (if they wish to remember something they have forgotten) and that makes them feel more emotional than when they read the personal diary. Finally, participants from the two groups agreed that SenseCam produces a sense of reliving the moments recorded in the pictures, which was not reported with the review of the diary.

Table 3. Subjective experience ratings, by age group and memory aid[a]

Subjective experience	Older Adults		Younger Adults		Main effect of memory aid (F statistic) df =1,27	Main effect of age group (F statistic)	Memory Aid Effect size, ε^2
	SenseCam Mean (SD)	Diary Mean (SD)	SenseCam Mean (SD)	Diary Mean (SD)			
Prompting memories[b]	0.93 (0.61)	0.50 (0.52)	1.53 (0.64)	0.80 (0.41)	18.38*	8.53*	0.45
Surprise[c]	3.29 (1.32)	1.86 (1.01)	4.40 (0.83)	2.33 (0.98)	43.94*	7.21*	0.62
Excitement[c]	3.71 (1.38)	1.86 (1.23)	4.13 (0.64)	2.04 (1.06)	46.77*	2.23	0.65
Alert[c]	3.79 (1.12)	2.21 (1.46)	4.07 (0.46)	3.33 (0.82)	15.19*	8.40*	0.36
Emotion[c]	2.31 (1.71)	1.86 (1.22)	3.33 (1.23)	2.07 (1.10)	8.07*	2.60	0.23
Helpful[c]	4.50 (0.56)	3.86 (1.16)	4.40 (1.24)	3.87 (1.87)	4.17*	0.03	0.13
Reliving events[c]	3.96 (1.17)	2.29 (1.44)	4.47 (0.74)	2.60 (1.24)	22.85*	3.29	0.46

[a] Example of a question from this questionnaire: "How did it feel to review the diary/SenseCam images? (please indicate how strongly you agree with each statement, where 1(one) indicates strongly agree and 5(five) indicates strongly disagree)…It felt exciting to review those three days." Participants were tested about their subjective experiences with this questionnaire at the end of each condition (diary/SenseCam). [b] Rating scale: 0 – didn't prompt any more memories; 1- prompted a few more memories; 2 - prompted a lot of more memories; [c] Rating scale from 1 to 6, 1 meaning absence of that subjective experience and 6 meaning complete presence of that subjective experience.

1.4. Discussion

This study tested whether previously reported improvements in recall of events following the review of SenseCam images generalized to the improvement of cognitive performance. Firstly, the results extend previous findings which show SenseCam improves autobiographical memory by cuing events continued in the images.[5,7,8] It was found that SenseCam also improves performance on a test which measures autobiographical memory for events not captured in the SenseCam images, relative to a diary condition. To reiterate, the Autobiographical Memory Test concerns the whole lifespan, not the limited content of the SenseCam or diary period. Thus, SenseCam review appears to improve the specificity and level of detail of autobiographical memory from across the lifespan.

Second, an effect of SenseCam is present in domains other than autobiographical memory as evidenced by a superior performance in tasks that tested learning a list of words (California Verbal Learning Test), as well as the brief registration of digits and reordering months (classic tests of working memory and executive function) and also the generation of category exemplars (a measure of semantic memory). This research suggests that SenseCam may operate as a cognitive stimulant in daily life for a healthy population. Further research should attempt to clarify what aspect of SenseCam review leads to this effect. Is it the review of any pictures which is stimulating? Could it be the emotional effect of using a novel gadget? We tentatively suggest that this effect of SenseCam review could stem from the fact that neuroimaging studies have shown it to produce pronounced activation in the hippocampus, an area of the brain critical for memory function.[10] However, the subjective report in the final questionnaire may be useful for the understanding of the basis of the SenseCam effect; these ratings suggest that the improvement in cognitive function may be related to the feelings of alertness, and the pleasure of using the device. Indeed, previous research has shown that using technology to assist cognition is motivating[23] and contributes to a stronger feeling of self-efficacy and an improved mood.[24]

On the other hand, the fact that SenseCam is a passive assistive technology for cognition may explain why the effect worked equally for old and younger adults. Even though older adults had poorer performance overall, they still benefited from review of pictures. This is possibly because review does not require the intentional processes which decline with age.[25] These are, however, provisional suggestions about the processes underlying the effect seen here which we will try to clarify with forthcoming experiments.

To put these results in context, a recent review of memory training in aging[26] stated that that the focus must be put in compensatory strategies more than in internal strategies and that compensatory strategies must be user-friendly, and require as little training as possible so that the compensatory overactivation can occur and promote significant effects improving the cognitive performance of the ageing person. We consider that this study is in accordance with this perspective. The critical issue would now be evaluating this kind of compensatory memory aids for longer periods of time, so that we can gauge its effectiveness and usability in the long term.

There are some limitations which need noting. Although this study produced some large effect sizes on standardized measures of function, it should be noted that this experiment was run with a convenience-based sample, with participants motivated to use SenseCam. The fact that only a healthy population was tested in this study is also a constraint of this study. Consequently, it is still unknown whether this general benefit of SenseCam is circumscribed to participants without cognitive problems or if this effect is replicated in patients with memory deficits. Most critically, the effect we find here is immediate, and possibly short term. As such, the aim of our larger research programme is to address these limitations by examining the generalization of the effect of SenseCam to other cognitive areas in a clinical sample (patients with Mild Alzheimer's disease). In this larger investigation a more complete cognitive assessment battery will be administered and we will test SenseCam for longer periods of time in patients, with a baseline, a post-intervention and a follow-up assessment.

1.5. Conclusion

Hitherto, research with devices like SenseCam has focused on the use of technologies as compensatory aids for memory. This view emphasised 'cognitive prosthetics' because they were considered to act as a substitute for cognitive function following impairment. This idea has dominated the field of the memory aids in general[1] and in new technologies in particular[22]. Our study provides a novel perspective where we find a stimulation of cognition following SenseCam review. This suggests SenseCam has an action which is more than just supporting or compensating for a lost memory, it may actually act to improve it. Since SenseCam is a passive memory aid, with no need for training, if we could prove its efficacy to delay the appearance of symptoms associated with neurodegenerative diseases it could reduce substantially the resources normally required in these kinds of conditions.

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2.1. Estudo 2a – Testing the promise of new technology: The cognitive effects of wearable cameras in mild Alzheimer disease

Submetido: Silva, A.R., Pinho, M.S., Macedo, L., & Moulin, C. (submetido). Testing the promise of new tecnhology: The cognitive effects of wearable cameras in mild Alzheimer disease.

Abstract

Wearable cameras offer a new type of intervention aimed at stimulating memory in Alzheimer's disease (AD). Such passive external memory aids have started to be considered as alternatives to both active aids (such as writing in diaries, journals, and timetable) and to internal cognitive strategies (such as spaced retrieval, errorless learning). In order to understand the benefits of these innovative devices for memory compensation, the present study examines the effectiveness of two memory training strategies: SenseCam, a wearable camera, a passive external memory aid and a memory training programme (MEMO+) created from tasks known to stimulate memory in comparison to a control condition, a personal written diary that was an active external memory aid. Fifty-one patients with mild AD were randomly assigned to one of these three groups. Training lasted for six consecutive weeks, two sessions a week, one hour each, for all groups. Patients underwent a neuropsychological assessment at baseline, after treatment and at follow up (six months later). All groups were cognitively matched at baseline. After treatment and at follow up, the SenseCam group had a superior autobiographical memory (AM) performance, compared to the Memo+ and Diary groups. The SenseCam and the Memo+ groups both showed improved episodic and semantic memory, and a somewhat improved executive function. Our results suggest that passive

memory training with SenseCam is a promising alternative to traditional memory training programs to help AD patients with their memory deficits.

Keywords: Alzheimer's disease; memory; cognitive training; wearable cameras; non-pharmacological interventions; senseCam.

2.1.1. Introduction

The development of wearable cameras has brought new possibilities to the field of memory rehabilitation [for a review see 1]. SenseCam, originally built with the purpose of being a "retrospective memory aid" [2] has been shown to support memory impaired populations' ability to remember personal events. This camera automatically takes pictures from the wearer's point of view, without his/her intervention, requiring no active encoding of the information to be later remembered. The still images are later reviewed as a sequence like a movie using a personal computer. The initial findings were that SenseCam images effectively cued the retrieval of information depicted in the images even after an interval of eleven months [3,4].

These initial findings also pointed to the idea that SenseCam could stimulate memory more generally. For example, Hodges and colleagues [2] suggested that seeing SenseCam images allowed people to remember information not depicted in the images, something that we referred to as the retrieval of 'something more' [1]. In support, a study using a battery of neuropsychological assessment measures revealed that reviewing SenseCam images improved healthy young and older adult test scores, for measures not related to the content of the SenseCam images [5]. In particular, this finding was deeply marked for autobiographical memory. Using a standardized autobiographical memory assessment measure (the Autobiographical Memory Test, AMT) [6] and a within subject design, SenseCam showed a strong effect (η^2_p =.82) compared to a written diary control condition. Such a finding was interpreted as reflecting how SenseCam review mimics autobiographical memory (first person point of view, visual information, structured in brief time slices, reviewed in a temporal order). That is, SenseCam review should stimulate networks of neurones involved in memory retrieval. This stimulation hypothesis predicts that SenseCam review should lead to generalised benefits not just for the retrieval of information depicted in the images, through the activation of otherwise impoverished neural structures. Critically, this hypothesis receives support from neuroimaging studies which show that SenseCam review in healthy groups leads to activations in the hippocampus and temporal lobe more generally [7,8].

To date, there has been relatively little evaluation of the benefits of SenseCam in Alzheimer's disease (AD), and no systematic study on the generalized benefits of SenseCam review on measures of neuropsychological function. Specifically, in AD, there is an inability to travel mentally back in time and bring to consciousness past events; episodic memory is compromised even in the mild stages of this disease [9, 10]. As such, both anterograde and retrograde memory are impaired, with difficulties in encoding and retrieving recent experiences and deficits in retrieving specific autobiographical memories (AM) from earlier in life. Thus, in AD we see disproportionate deficits in Autobiographical Memory (AM), but in turn it is this type of memory which seems to benefit most from rehabiliation using SenseCam, at least so far in healthy groups [5]. Importantly, the intimate relationship between AM and identity [11,12] pinpoints the highly disruptive effects the impairment of this type of memory domain in mild AD can have on patients' quality of life. The progressive decline in memories that built the person's self-concept will influence well-being. Despite being one of the areas of cognition most critical for autonomy and well-being, autobiographical memory is difficult to treat or rehabilitate due to its personal and subjective nature, but technological innovations such as SenseCam, can now re-present people with personally-relevant materials in a way that was not otherwise possible.

To put SenseCam research into context, non-pharmacological interventions in AD started with the application of intensive memory-based interventions that required substantial cognitive effort and drew heavily on episodic memory [13,14] The weak efficacy and lack of generalization effects produced by this approach contributed to the rise of another category of interventions, driven by technological advances; the use of external memory aids or “memory prosthetics” [15]. These techniques are commonly used in memory-impaired patients with treatable and non-progressive conditions [16], and they have started to be tested with people with AD more recently. For episodic memory, compensatory strategies are considered more effective than restitution oriented strategies [17,18]. Moreover, rehabilitation techniques which are ‘passive’ are likely to be more effective and rewarding than active techniques, such as memory training, which are intensive and cognitively demanding [1].

Thus far, to our knowledge, there are only three published studies using SenseCam as a memory aid for patients with Alzheimer disease. Lee and Dey [19] tested three patients with mild AD. These patients wore the SenseCam for two weeks but only for personally significant events (as considered by the patient or its caregiver). The use of the camera by the patient increased the recall of details of the events compared to the used of the camera by his caregiver or no treatment. Crete-Nishiatha et al. [20] tested SenseCam usage during three outings in five patients with AD. It was used an adapted autobiographical interview, and these patients again showed an increase in recall of the events depicted by the SenseCam images. Finally, Woodberry et al. [21] tested the efficacy of SenseCam to improve recall of information about personally significant events in six patients with mild AD, compared to the effects of a personal Diary intervention (writing in the diary the interesting events of the day), in a within subjects’ design.

Patients wore the SenseCam, again only for personally relevant events, over a three-month period. Five of the six participants recalled more details from the SenseCam-cued events compared to the Diary condition. This effect remained at three-month follow up. These results suggest that SenseCam is helpful in AD population, and can stimulate recall of specific autobiographical memories depicted in the images. However, it is unknown if this effect is generalizable to global autobiographical memory function, and indeed to other memory domains.

In the present study we examined the efficacy of SenseCam to stimulate cognition in a group of patients with mild AD. One previous study with a healthy population has tested global cognitive effects of SenseCam [5]. Using this as basis, we will test a sample of mild AD patients on a similar set of standardized measures with an emphasis on the improvement of AM (justified for the fact that previous studies suggest the efficient role of SenseCam to stimulate AM). We will also examine other relevant cognitive domains (tests of episodic memory, semantic memory, attention and executive function) [22]. To date, SenseCam studies in AD have used no-aid/no-treatment conditions [19] or a personal written diary [21] as control conditions. This last type of intervention, despite ethically being acceptable, is expected to be ineffective for most AD patients, even in the mild stages, due to some constraints of its use (the need to remember to fill the entries and to remember the past events in order to correctly fill the diary) [15]. Consequently, to examine in depth the value of SenseCam effectiveness, one should compare its effects to interventions that are expected to be efficacious for this purpose. To this end, a memory training programme – Memo+ (see Methods section for description in detail), was constructed, based upon the most recent advances in terms of internal strategies effective for AD patients' memory functioning, such as errorless learning, spaced retrieval and mnemonics training. SenseCam will be compared with this memory training program and we aim to reflect on the differential effects between a compensatory passive approach and a restorative active approach intervention.

2.1.2. Method

Participants and Design

Fifty-one patients with mild AD took part in this study (aged 62 to 80 years, *M* = 73.65, *SD* = 5.498). They were recruited from the Psychiatric and Neurology services of Coimbra University Hospital (CHUC), at the Portuguese Alzheimer's Disease Association (APFADA) and at the Residential Care Facility at Rainha Santa Isabel. Participants met the following criteria: a diagnosis of probable AD (according to the NIA-AA workgroup criteria) [23]; diagnosis established within the past six months; community-dwelling or integrated into a day care centre; and cared for by a well-identified caregiver willing to participate in the study; score between 15 and 26 on the Mini-Mental State Examination (MMSE) [24]; absence of severe symptoms of depression (according to the score on the Geriatric Depression Scale (GDS) [25]; and severity between very mild (0.5) and mild (1.0), according to the Clinical Dementia Rating (CDR) [26]. The study procedures were approved by the research ethics board of the Hospital Centre of the University of Coimbra (CHUC) (ethics approval number 4212). All participants provided informed consent.

After screening, participants that met the criteria for the study were randomly assigned to one of three groups of cognitive training (See Figure 1 for the study protocol). One-way ANOVAs demonstrated no significant difference between groups for age, $F(2, 48) = 1.475$, $p = .241$, level of education (years of formal education), $F(2, 48) = 2.340$, $p = .109$), or estimated premorbid IQ on the Portuguese version of the National Adult

Reading test (TELPI – Teste de Leitura de Palavras) [27], *F*<1. The groups did not differ on general cognitive status according to the Addenbrooke's Cognitive Examination (ACE-R) [28], *F*<1 at baseline. The length of the cognitive training programmes was six weeks, and there were two post-intervention assessment visits: one immediately after the end of the rehabilitation sessions and a six-month follow up. Only 46 patients took part in the third assessment (dropouts were due to the following reasons: two participants died during the follow-up interval and three participants changed address, missing the third visit).

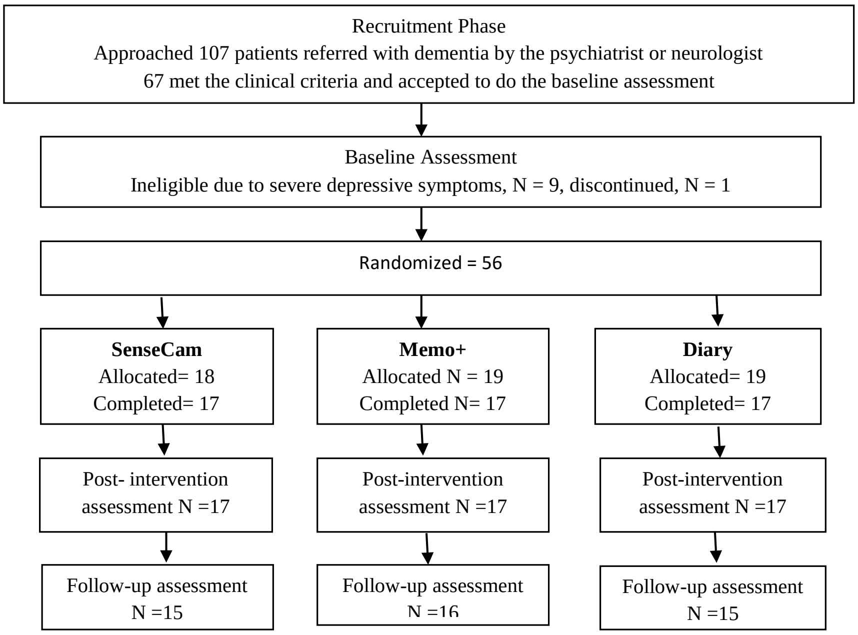


Figure 1. Study protocol and number of participants in each study phase

Cognitive training interventions

We compared three different interventions: a wearable camera (SenseCam group), a. memory training programme with paper and pencil exercises (Memo+ Group) and a personal written diary (Diary Group). The number of sessions for each type of intervention was the same (eleven sessions, twice a week, one hour per session).

SenseCam Group. In this memory training group, SenseCam was used to capture images from participants' daily life. These were then shown on a computer during sessions with the neuropsychologist. Participants from this group were instructed to wear the camera every day for the longest possible time in order to maximize the potential of the device and the number of images gathered, but they were also informed that they could remove or turn off the camera for any events they wanted to remain private. Patients and their caregivers were instructed, before starting to use the device, on how to charge it and how to use the buttons (privacy, on/off button, manual trigger). During the training sessions, the participants reviewed the images and were asked to comment on what they were watching, but the neuropsychologist did not give feedback on the accuracy of those comments.

Memo+ Group. This programme of cognitive training included a set of paper and pencil exercises to stimulate cognition. It was developed based on recent advances in memory training of people with AD. We selected tasks and techniques where there was published evidence of memory improvement in brain injury. In short, we included training and practice in the following domains: exercises to practice motivation [29], attention [30], working memory [31], autobiographical and episodic memory [32, 33, 34, 35, 36] semantic memory [37] and implicit memory [38]. Training sessions involved the practice of cognitive strategies for learning and retention of information (spaced retrieval, vanishing cues, errorless learning, mnemonics). Exercises had progressive levels of difficulty throughout the training sessions. At the end of each session, feedback from the neuropsychologist (ARS) was given concerning the performance of the participant on each exercise.

Personal Diary Group (Control Condition). In this intervention group, participants were asked to write down their daily activities in a personal journal with sections to fill in and to then read it to the experimenter in each session. The diary was organized into sections on a one-page-per-day basis. Sections were the following: Event description (where the participant writes the activity done in that day, for example, *"I had breakfast with my wife"*); Time (where the participant had to register the time of the day the event took place, for example, *"7.30 a.m."); place* (to fill with information about where the event took place, for example, *"in my kitchen"*); people involved (where the participant had to describe other people that were part of the event described, for example, *"my wife Maria");* and emotional description (where the participant was asked to described how they felt during the event, for example, *"calm"*). Two other sections were also included as aids for prospective memory: Appointments and Other Notes. The participant was instructed to fill the diary pages at the end of each day, and carers were instructed to remind the participant to complete the diary.

Neuropsychological evaluation

A comprehensive set of neuropsychological tests was applied at three time points: 1) baseline (before randomly assigning participants to each cognitive intervention); 2) after intervention (the week after the six-weeks intervention ended); 3) follow-up (approximately six months after the end of the intervention). The full set of instruments described in Table 1 was applied at the three visits.

Table 1. Neuropsychological tests

Test	Domain assessed
Autobiographical Memory Test - AMT (Williams & Broadbent, 1987; Portuguese version Bobrowicz-Campos et al., 2010)	Autobiographical memory as cued by key words. This measures the memory for personal events from across the lifespan.
Word Lists (Wechsler Memory Scale –3rd edition; WMS-III Wechsler, 1997/2009)	Verbal episodic long term memory,
Route task from the Rivermead Behavioural Memory Test - III (RBMT-III; Wilson et al., 2006)	Visuo-spatial episodic long term memory, and prospective memory
Digit Span (WMS-III, Wechsler, 1997/2009)	Short-term memory, working memory/executive function
Verbal fluency – phonemic	Lexical access, executive control/inhibition, processing speed
Verbal fluency – semantic	Verbal semantic memory, executive control/inhibition, processing speed
Pyramids & Palm Trees (P & P) – pictures version (Howard & Patterson, 1992)	Semantic memory
The keys sub-test task from the Cambridge Prospective Memory Test (CAMPROMT, Wilson et al., 2005)	Time-based prospective memory
Digit Symbol Coding (Wechsler Adult Intelligence Scale – 3rd edition; WAIS-III; Wechsler, 2008)	Speed of processing, attention

2.1.3. *Results*

Participant characteristics

The groups to which the participants were assigned in this study were randomized and showed no significant differences on sociodemographic variables, as well as for general cognitive function and depressive symptoms. Table 2 describes the characteristics of the sample at baseline

Table 2. Participant characteristics at baseline: neuropsychological assessment (N=51)

	Memo+ N=17 *Mean (SD)*	***SenseCam N=17*** *Mean (SD)*	***Diary (control) N=17*** *Mean(SD)*
Age	71.71 (5.15)	75.41 (5.26)	73.82 (5.74)
Range	63-78	62-80	62-79
Years of education	5.18 (3.68)	4.76 (3.47)	6.76 (4.63)
Range	3-15	2-15	2-15
Mini Mental State Examination (MMSE)	21.53 (3.01)	21.88 (3.33)	22.82 (1.85)
Range	16-26	16-26	19-26
Addenbrooke Cognitive Examination – Revised (ACE-R)	63.18 (7.67)	63.12 (7.47)	61.06 (8.25)
Estimated premorbid IQ (TELPI – Portuguese version of NART)	94.00 (13.38)	97.57 (12.03)	99.23 (15.41)
Clinical Dementia Rating (CDR)	0.91 (0.19)	0.85 (0.23)	0.94 (0.16)
Geriatric Depression Scale (GDS)	11.88 (4.83)	13.35 (6.02)	12.76 (5.92)

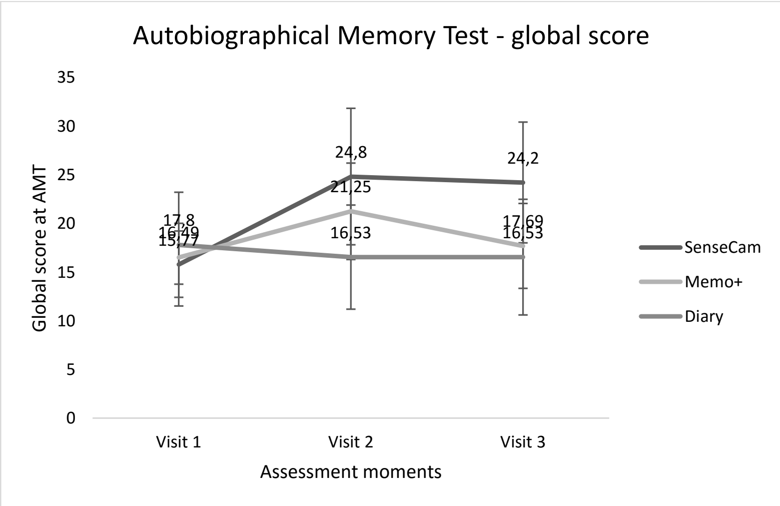
Neuropsychological assessment

Our strategy for analysis was to use mixed 3 x 3 ANOVAs with Group (SenseCam versus Memo+ versus Diary) as a between subjects' factor and Visit (Baseline, After cognitive training and at Follow-up) as repeated measures factor. Since there were 46 patients at follow up, this means that our principal analyses were conducted on 46 patients. Where indicated we carried out group comparisons using Bonferroni corrected Fisher's LSD comparisons and paired sample t-tests.

One-way ANOVAs were performed before the mixed 3x3 ANOVAS to compare the groups' scores at baseline. The variables where groups differed at baseline were the following: World List learning, $F(2,48)=2.78$, $p=.06$, World List recognition, $F(2,48)=3.20$, $p<=.05$; Digit span global score, $F(2,48)=2.95$, $p=.06$; and Semantic global score, $F(2,48)=4.69$, $p<.01$. For these variables we did not carry further analyses. Because of previous studies in this domain, and indeed the design of the SenseCam, we had a particular focus on autobiographical memory function, and we analyse this domain before considering the remaining neuropsychological instruments' results in detail.

Autobiographical memory (AMT) [6]

As our primary outcome, we examined the global score in this instrument (obtained by the multiplication of the number of memories recalled after the 15 keywords given and the specificity of those recalled memories). For this global score, a main effect for Group was found, $F(2,43)=3.94$, $p=.02$, $\eta^2_p = .16$, and Fisher LSD post-hoc comparisons revealed that scores were higher for the SenseCam group in comparison to both the Memo+ group (p=.05) and the Diary group (p=.01). A main effect was also found for Visit, $F(3,43)= 22.94$, $p<.01$, $\eta^2_p = .35$, and LSD pairwise comparisons with Bonferroni adjustment showed higher results in Visit 2 compared to both Visit 1 (p<.001) and Visit 3 (p=.023), and higher results in Visit 3 compared to Visit 1 (p<.001). Finally, an interaction effect was found for Group x Visit, $F(3,43)= 16.81$, $p<.01$, $\eta^2_p = .44$, . The interaction arises because whereas the SenseCam group improves between the first two visits and maintains this improvement for the third, the Dairy group shows no improvement at all, and the Memo+ group shows some improvement but this is not retained for the follow up visit (see Graph 1). That is, the SenseCam group's AM performance improved at Visit 2 (M=24.80, SD=7.01) compared to Visit 1 (M=15.77, SD=4.25, $t(16)=8.32$, p<.01) and Visit 2 scores remained at about the same level for Visit 3 (M=24.20, SD=6.21, $t(14)=-1.45$, p=.17). The Memo+ group performance also improved at Visit 2 (M=21.25, SD=4.95) compared to Visit 1 (M=16.49, SD=2.72, ($t(16)=4.11$, p<.01), but decreased at Visit 3 (M=17.69, SD=4.37), with no differences between visits 1 and 3, ($t(14)=1.78$, $p=.09$). The Diary group performance maintained stable over the three time points of assessment, revealing the absence of an effect of training in this group (Visit 1 M= 17.80, SD=5.39; Visit 2, M=16.53, SD=5.35; Visit 3, M=16.53, SD=5.93, *p*=n.s. for all pairs).



Graph 1. Group means of the global score of the Autobiographical Memory Test, across the three assessment visits

As this instrument examined both the number of memories recalled and the specificity of those memories, we will analyse in depth the level of specificity of the memories recalled by the patients in each group. Memories collected with AMT can be rated as a semantic association, a categorical memory, an extended general memory; or a specific memory. As the level of specificity is associated with the quality of AM performance (specific memories are rated with 3 points, the maximum score possible), we analysed the total of memories rated as specific in each intervention group. As for the global score, a main effect for Group was found for specific memories, $F(2,43)=6.41$, $p<.01$, $\eta^2_p = .23$, and Fisher LSD post-hoc comparisons indicated that the number of specific memories retrieved by participants in the SenseCam group was higher than the Memo+ group (p<.01) and the Diary group (p<.01). A main effect was again found for Visit, $F(3,43)= 33.44$, p<.01, $\eta^2_p = .43$, and performing LSD pairwise comparisons with

Bonferroni adjustment revealed than in Visit 2 more specific memories were produced in comparison with Visit 1 ($p<.001$) and Visit 3 ($p=.008$), but a higher number of memories with greater specificity were retrieved at Visit 3 compared to Visit 1 ($p=.001$). An interaction effect of Group x Visit was also found for the retrieval of specific memories, $F(3,43)=16.31$, $p<.01$, $\eta^2_p = .43$. The analysis of the means and additional paired-sample t tests indicated that the SenseCam group's specificity increased at Visit 2 (Visit 1 M= 1.33, SD=1.01; Visit 2 M=4.73, SD=2.78, $t(16)=5.91$, $p<.01$) and was maintained at Visit 3, with no differences between these two visits (M=4.67, SD=2.74, $t(14)=1.00$, $p=.33$), whereas in Memo+ the specificity is improved at Visit 2 (Visit 1 M=1.25, SD=1.13; Visit 2 M=2.81, SD=1.90, $t(16)=4.96$, $p<.01$) but significantly decreased at Visit 3 (Visit 3 M=1.63, SD=1.50, $t(14)=-4.28$, $p<.01$), returning to the baseline level of performance ($t(14)=1.69$, $p=.11$). The Diary group's specificity did not differ between assessments (Visit 1 M=1.71, SD=1.21; Visit 2 M=1.76, SD=1.56; Visit 3 M=1.47, SD=1.24; *p*=n.s.). In short, as hypothesised, there is a clear and maintained benefit of SenseCam review on the accessibility and specificity of autobiographical memories.

Other cognitive domains

We present in Table 3 the complete set of results in the neuropsychological assessment measures without baseline group differences at the three time points for the three groups.

Table 3. Means, standard deviation and p values for within-group differences in the complete set of standardized cognitive assessment measures

	SenseCam			**Memo+**			**Diary**		
	1 N=17	**2** N=17	**3** N=15	**1** N=17	**2** N=17	**3** N=16	**1** N=17	**2** N=17	**3** N=15
Word List immediate	16.26 (3.33)	**20.40**[a] (4.84)	**20.13**[a] (4.43)	16.87 (5.18)	**21.18**[a] (6.38)	**18.75**[a,b] (6.40)	15.00 (4.23)	**13.33**[a] (4.19)	14.00 (4.23)
Word List short delay	0.93 (1.09)	**2.00**[a] **(1.19)**	**1.80**[a] **(1.32)**	2.06 (2.14)	**3.00**[a] **(2.16)**	2.50 (2.25)	1.80 (1.24)	**0.66**[a] **(1.04)**	**0.40**[a] **(0.62)**
Word List long delay	0.53 (0.91)	**1.73**[a] (1.43)	**1.47**[a] (1.35)	1.63 (2.09)	**2.93**[a] (2.11)	2.06 (2.32)	1.06 (1.75)	0.60 (1.21)	0.20 (0.41)
Word List retention (%)	12.00 (10.7)	**27.70**[a] **(22.9)**	**21.95**[a] **(19.5)**	25.88 (27.0)	**45.24**[a] **(23.2)**	33.32 (30.1)	25.75 (14.1)	10.56 (9.03)	6.47 (4.11)
Route task immediate	8.20 (2.01)	**10.73**[a] **(2.71)**	**9.87**[a,b] **(2.92)**	8.63 (1.50)	**9.88**[a] **(1.54)**	8.63 (1.50)	8.40 (0.51)	8.07 (0.26)	8.16 (0.47)
Route task delayed	4.67 (1.63)	**6.40**[a] (1.81)	**6.07**[a] (2.25)	5.44 (0.77)	5.81 (0.41)	5.84 (0.72)	4.93 (0.46)	4.47 (0.84)	4.93 (0.46)
Digit Span forwards	7.00 (1.80)	7.47 (2.06)	7.20 (2.18)	6.06 (0.99)	**6.88**[a] (1.66)	6.63 (1.62)	6.47 (1.06)	**5.40**[a] (1.29)	**5.40**[a] (1.24)
Digit Span backwards	4.00 (1.06)	4.57 (1.45)	4.47 (1.41)	3.50 (0.82)	**4.75**[a] (1.73)	**4.56**[a] (1.50)	3.07 (0.79)	**2.73**[a,c] (0.88)	**2.20**[a,b] (0.56)
Verbal Fluency – phonemic	21.60 (11.5)	**26.60*** (8.96)	**26.27*** (9.36)	22.25 (15.3)	24.56 (14.1)	23.69 (13.0)	17.93 (8.00)	**16.13**[a,c] (7.18)	**14.20**[a,b] (6.06)
Pyramids & Palm Trees	39.33 (4.82)	**44.33*** (4.03)	**41.20*** (5.01)	43.00 (4.54)	**45.44*** (3.50)	**45.51*** (3.51)	40.27 (5.28)	39.93 (5.42)	**37.63**[a,c] (5.32)
Prospective memory	3.13 (1.36)	**5.33**[a,c] **(0.97)**	**4.13**[a,b] **(1.41)**	3.13 (1.41)	4.06 (1.81)	3.38 (1.20)	3.47 (1.19)	**4.00**[c] **(1.07)**	**2.53**[a,b] **(1.19)**
Symbol-Digit Coding	15.47 (6.68)	18.00 (7.64)	16.93 (6.42)	19.25 (12.22)	23.19 (16.02)	19.88 (12.27)	19.93 (9.08)	17.80 (7.36)	16.07 (6.53)

Note: Bold numbers indicate within group differences as measured by pairwise comparisons: a = significantly different (p<.05 corrected) from Visit 1; b = significantly different (p<.05 corrected) from Visit 2; c = significantly different (p<.05 corrected) from Visit 3.

Episodic Memory

Word List (WMS-III) [39]

The word list test yields several measures. For *immediate recall*, an effect of Group was found, $F(2,43)=5.47$, $p<.01$, $\eta^2_p = .20$, and post-hoc LSD comparisons revealed that the SenseCam group (LSD, p=.01) and the Memo+ group (LSD, p=.01) had a superior performance to the Diary group, but that the Memo+ and SenseCam groups did not differ (LSD, p=.99). An effect of Visit was also found, F(2,43)=14,67, p<.01, η^2_p = .25 and LSD pairwise comparisons with Bonferroni adjustment identified lower scores in Visit 2 compared to Visit 1 (p<.01) but not to Visit 3 (p<.17), and higher scores in Visit 3 compared to Visit 1 (p<.01). An interaction effect was found for Group x Visit, *F*(2,43)= 23.13, p<.01, η^2_p = .36, where the SenseCam group scores increased at Visit 2 remaining at the same level at Visit 3, the Memo+ group scores increase at Visit 2 but decreased at Visit 3 (despite to a level superior to baseline – Visit 1), and the Diary group scores decreased at Visit 2.

Similar results were found for *short delay recall*, with a main effect of Group, F(3,43)=4.53, p=.01, η^2_p =.17, with the Memo+ group having an improved performance comparatively to the control group Diary (LSD, p<.01), without other significant group differences. No main effect for Visit was found (p=.22) but an interaction of Group x Visit was found, F(3,43)=7.97, p<.01, η^2_p =.27, indicating that for the SenseCam group the two Visits after the intervention (2 and 3) held similar scores, both higher than Visit 1. The Memo+ group scores were only superior to baseline at Visit 2, and the Diary group scores followed an opposite pattern, decreasing at Visit 2.

For the *long delay recall* scores, a main effect of group was also found, F(3,45)=5.50, p<.01, η^2_p =.21, with higher scores for the Memo+ group compared to the Diary group (LSD, p<.01). A main effect of visit was found, F(3,43)=4.53, p=.01, and LSD pairwise comparisons indicated that scores increased at Visit 2 compared to Visit 1 (p<.01) which was somewhat maintained at Visit 3 (p=.07), whose scores did not differ from Visit 1. An interaction effect was also found, F(3,43)=3.86, p<.01, , η^2_p =.15, as the SenseCam group scores increased at Visit 2 compared to Visit 1 and were maintained at follow-up, whereas the Memo+ group scores increased at Visit 2, but returned to the Visit

1 level at Visit 3. In the Diary group, despite there being a decrease in the scores across visits, these differences were not statistically significant.

Finally, for the *retention rates*, an effect of Group was found, F (3,43) = 4.71, p=.01, η^2_p =.18, and post-hoc Tukey LSD indicate that the Memo+ group had higher scores than the Diary group (LSD, p=.01) without any further differences identified. No effect of Visit was found, F(3,43)=1.89, p=.16, but an interaction was found between Group and Visit, F(3,43)=4.07, p<.01, η^2_p =.16. The interaction analysed through paired samples t-test indicated that, as for the previous scores, the SenseCam group retention rates increased at Visit 2 and remained superior to baseline at Visit 3, and the Memo+ group scores only increased at Visit 2, approaching Visit 1 levels at Visit 3.

Rivermead Behavioural Memory Test – III, route task (RBMT-III) [40]

For the Route task of the RBMT-III, in the *immediate recall,* the effect of Group only approached significance, F(3.43)=2.44, p=.09. An effect of Visit was found, F(3.43)=27.22., p.01, η^2_p =.39, and LSD pairwise comparisons with Bonferroni correction showed that scores increased at Visit 2 compared to Visit 1 (LSD, p<.01), and decreased at Visit 3 compared to Visit 2 (LSD, p<.01). An interaction effect for Group x Visit was found, F(3, 43)=16.61, p<.01, η^2_p =.44, with SenseCam group scores increased at Visit 2. Despite decreasing at Visit 3, the SenseCam group's scores remained above baseline levels. In the Memo+ group, the scores at Visit 3 were statistically similar to baseline/Visit 1.

For *delayed recall*, an effect of Group was found, F(3,45)=9,68, p<.01, η^2_p =.19, where the SenseCam group (LSD, p=.02) and the Memo+ group (LSD, p=.05) had a superior performance to the Diary group, and these two groups did not differ (LSD, p=.71). A main effect of Visit was found, F(3,43)=9.68, p<.01, , η^2_p =.18, with scores being higher at Visit 2 compared to Visit 1 (LSD, p<.01), without significant differences between Visit 2 and Visit 3 (LSD, p=1). An interaction effect was found for Visit x Group, $F(6,41)= 12,81$, $p<.01$, $\eta^2_p =.37$. Only the SenseCam group showed significant differences between the baseline assessment (Visit 1) and the Visit 2, and the higher scores at Visit 2 were maintained at Visit 3.

Keys sub-test task (CAMPROMT) [41]

For the CAMPROMT time based prospective memory task, the main effect of group approached significance, $F(3,43)=2.47$, $p=.09$, but a main effect of Visit was found, $F(3,43)=29.86$, $p<.01$, $\eta^2_p =.37$, and there was an interaction between Group and Visit, $F(3,43)=6.61$, $p<.01$, $\eta^2_p =.24$. The SenseCam group scores increased after the intervention (Visit 2) and remained above baseline at follow-up (Visit 3), whereas the Diary group scores decreased at follow-up. The Memo+ group scores were not different across visits.

Semantic Memory

Pyramids and Palm Trees (P & P) – pictures version [42]

For this task, a main effect of Group was found, $F(3,45)=5,60$, $p<.01$, $\eta^2_p =.21$, with the SenseCam (LSD, p=.06) and the Memo+ group (LSD, p<.01) having a superior performance than the Diary group, without differences between the SenseCam and the Memo+ groups (LSD, p=.15). A main effect of Visit was also found, $F(3,45)=22.90$, $p<.01$, $\eta^2_p =.35$ with higher performance in Visit 2 compared to Visit 1 (p<.01) and no significant differences between visits 1 and 3 (p=.54). An interaction was found between Visit and Group, $F(6,41)=13,77$, $p<.01$, $\eta^2_p =.39$. The SenseCam group scores indicated higher scores both at Visit 2 and Visit 3 compared to Visit 1, but also higher scores were obtained at Visit 2 compared to Visit 3 indicating some loss at follow up. In the Memo+ group, the improvement of the scores at Visit 2 was maintained at Visit 3, compared to baseline. The Diary group scores followed the opposite path, maintaining stable at Visit 2 compared to Visit 1, and decreasing significantly at Visit 3.

Attention and Executive Function

Digit span (DS) task (WMS-III) [39]

This instrument yields results for both forwards and backwards tasks, which we will analyse separately. For the DS forwards, a main effect of Group was found, $F(3,43)=3.72$, $p=.03$, , $\eta^2_p=.15$, and Post Hoc LSD indicated that only SenseCam scores were significantly higher than the control group – Diary (LSD, $p=.02$), without any additional differences between each other pair of groups (Memo+ and SenseCam, LSD, $p=.39$; Memo+ and Diary, LSD, $p<.33$). A main effect of Visit was not detected an interaction was found, $F(3,43)=7.10$, $p<.01$, , $\eta^2_p=.25$. The SenseCam group scores did not change across Visits, whereas the Memo+ group scores improved at Visit 2 but decreased at Visit 3 to a similar mean score to Visit 1. The Diary group scores decreased after the intervention – Visit 2 compared to baseline, and remained stable at baseline.

For the DS backwards, a main effect of Group was found, $F(2,45)=11.79$, $p<.01$, $\eta^2_p=.35$, and post-hoc LSD comparisons showed that both SenseCam group ($p<.01$) and the Memo+ group ($p<.01$) have a higher performance than the Diary group, and these two groups did not differ ($p=.92$). A main effect for Visit was also found, $F(2,46)=5.14$, $p=.01$, $\eta^2_p=.11$, with an improved performance in Visit 2 compared to Visit 1 ($p=.03$), but no differences between Visit 3 and Visit 1 ($p=.47$). An interaction between Visit x Group was found, $F(4,44)=9.04$, $p<.01$, $\eta^2_p=.30$. In the SenseCam group, no differences between assessments were found. In the Memo+ group, participants had higher scores in Visit 2 compared to Visit 1, maintained at Visit 3. In the Diary group, there is a decline in the scores at Visit 2 compared to Visit 1 and this decline is accentuated at follow-up – Visit 3.

Verbal fluency test

As explained above, due to differences at baseline in semantic fluency, we only carried the mixed ANOVA analysis for the phonetic fluency task of this test. In this task, the main effect of Group approached significance, $F(2,45)=3.06$, $p=.06$. $\eta^2_p=.13$, and post-hoc LSD analysis revealed that the SenseCam group ($p=.02$) and the Memo+ group ($p=.05$) had a superior performance to the Diary group, without differences between these two groups ($p=.77$). A main effect for Visit was also found, $F(3,45)=4.07$, $p=.03$, $\eta^2_p=.08$ and an interaction of Group x Visit, $F(4,44)=7.93$, $p<.01$, $\eta^2_p=.27$. Only the SenseCam group revealed an effect of the intervention, with a higher result at Visit 2 compared Visit 1, which was maintained higher at Visit 3, without statistical differences from Visit 2. No differences across Visits were detected in the Memo+ group. The Diary group, contrary to the SenseCam group, revealed a pattern of progressive decline in performance, with significantly lower scores at Visit 2 compared to Visit 1, and with accentuated decline at Visit 3 compared to Visit 2.

Digit Symbol-Coding (WAIS-III) [43]

For this instrument, no main effects of Group or Visit, neither interaction effects were found.

2.1.4. Discussion

The present study aimed to examine the effectiveness of three different memory training interventions to stimulate memory and overall cognition in mild AD patients in a sample of 51 patients. The participants were assigned to three groups: one group wore the camera SenseCam daily and took part in sessions to review SenseCam images, another group took part in sessions of paper and pencil cognitive exercises to practice effective memory strategies, and the control group wrote a personal diary daily and took part in sessions to read and share with the neuropsychologist the diary entries. We tested the neuropsychological performance of these groups before, immediately after and six-months after the end of cognitive training sessions.

We considered the AM scores as the main outcome for our study, due to the impact in well-being and adaptation to the disease as previously described. All groups studied had a poorer performance on the AMT test at baseline compared to healthy older adults. (The whole sample in our study had a mean AMT score at baseline of 16.69, SD = 4.51, compared to Moses et al., where the healthy older adults mean was 22.20, SD= 5.65) [44]. The same was found for specificity (in our study the AMT specificity score at baseline is M=1.91, SD=1.11, and in Moses et al., 2004 was M=5.40, SD=1.83). However, in the present study, the participants that wore the SenseCam significantly improved their scores compared to the remaining intervention groups, and their scores remained higher at follow-up. The Memo+ group also experienced an improvement in AM scores after training but the effect was not maintained at follow-up. As expected, the Diary group experienced no effects of the intervention on AM.

These results are, on one hand, in line with previous research with wearable cameras such as SenseCam [1], suggesting that SenseCam pictures act as strong cues of autobiographical memories. However, this result extends such findings, since the AM measure used in this study was a measure of global AM (not related to a particular time point, or the contents of the reviewed images) and included the assessment of specificity. SenseCam use in the present study was effective in stimulating AM performance more generally, and not only to stimulate memory for specific events related to the pictures captured [3]. This generalization effect had been previously found with healthy older adults [5], but this is the first time that this effect has been examined in AD. We propose that this effect is related to the visual nature of the personally relevant images, which can mimic the nature of autobiographical memories, and which directly, and passively, innervates the memory networks in the brain [45, 1].

In our study we also aimed to analyze more deeply the effects of this wearable camera, not only by focusing in AM but also other memory areas (episodic and semantic memory), attention and executive function. While the Memo+ intervention included specific tasks aimed to stimulate attention [30], working memory/executive function [31], verbal episodic memory [34], visual episodic memory [32], prospective memory [35], neither the SenseCam intervention nor the Diary intervention were specifically structured to train any of these areas of cognition. Despite some limitations of our analyzes, due to baseline group differences in some of the specific measures of episodic memory, the data analyzed suggested that the SenseCam group and the Memo+ group increased their performance in episodic memory after the intervention in a similar way, compared to the Diary group. However, a difference was found in the long term effects of the interventions. While for the episodic memory measures, the SenseCam effects were maintained at follow up, in the Memo+ group only the effects in semantic memory scores were maintained at the six-month interval.

The obtained data was less clear for the measures related to executive function. Despite the expected finding concerning the absence of an effect in the measure of attention and processing speed (as it is known that for an attention and processing speed training to be effective it needs to be intensive and last at least fifteen to eighteen subsequent sessions, which is not the case for our study) [46], the remaining measures revealed different patterns of efficacy for each of the intervention groups. An advantage of SenseCam over the other two groups was found for verbal fluency (we only analyzed the phonetic fluency, due to the groups differences at baseline in semantic fluency), where this group increased performance after the intervention and that increase was maintained at follow up. The Memo+ group showed an advantage in the DS backwards task after the intervention, and this effect was maintained after six-months. Contrary to these positive effects, the Diary group revealed a progressive decrease in performance, compatible to the progressive and accelerated impairment in this cognitive domain in mild AD. These patterns of results of the Diary group is particularly relevant to consider that no practice or nursing effects occurred even with a short interval between Visit 1 and Visit 2; adding weight to our finding of positive effects in the SenseCam and Memo+ groups.

Although we can identify some limitations to this study, such as the existence of between group differences at baseline on some measures, or the absence of some instruments to assess more deeply relevant cognitive domains, this study represents an important first step being a relatively large group study examining the benefits of SenseCam using standardized measures. The superiority of SenseCam over an intensive memory training programme (Memo+) in memory performance and in some measures of executive function, suggests that such devices can be beneficial for memory stimulation for AD patients in the mild stages of the disease. Additionally, the similar effects of SenseCam and the Memo+ to improve episodic and semantic memory in a way that the gains were maintained in a six-month interval is a poof of both the power of SenseCam pictures as memory enhances [1] and also the importance of a multiple-task memory training programmes that help the patient to practice memory strategies that could help them in daily life [47, 48]. It would be interesting to perform sessions of cognitive training using both types (SenseCam and the Memo+) in order to understand if this complementary application would influence the magnitude of the positive effects found in this study. We do consider that the control group we used for this study is possibly not the most appropriate, as the lack of visual information in the Diary group intervention makes it a less comparable resource of cognitive training relatively to SenseCam and the Memo+ programme. We therefore think that a future study should perhaps include a control group with photographs taken with regular cameras [49] so that we are able to control for the presence of visual data to stimulate cognition.

In conclusion, as we predicted based on results in healthy older adults and on a handful of studies on small sample of patients, we find a benefit on cognitive performance of using SenseCam in Alzheimer's disease. Most importantly, we found improvements on autobiographical memory which were larger than for other forms of memory rehabilitation, and which were sustained after six months. Perhaps most importantly, we found generalized benefits of SenseCam review on autobiographical memory retrieval, on unrelated standardized test of function and not just for the retrieval of the events depicted in the SenseCam images. Of practical importance, where the benefits of SenseCam were matched or bettered by our Memo+ memory training programme, it must be remembered that review of SenseCam images is a passive activity which yields comparable results to the intensive, neuropsychologist-implemented memory training. We propose that further larger scale studies need to be carried out on the use of wearable cameras in AD, but that this, the largest studied carried out to date, suggests that this will be a promising avenue for the rehabilitation of memory.

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2.2. Estudo 2b - It is not only memory: Effects of SenseCam on improving well-being in patients with Mild Alzheimer Disease

Submetido. Silva, A.R., Pinho, M. S., Moulin, C. J., Macedo, L., Caldeira, S., & Firmino, H. (submetido). It is not only memory: Effects of SenseCam on improving well-being in patients with mildmild Alzheimer disease

Abstract

Background. There has been a growing interest in the development of effective cognitive interventions for patients in the milder stages of Alzheimer's disease (AD). From intensive cognitive training and mnemonics, to external memory aids which aim to compensate for lost function, research is needed to understand to what extent effects of such interventions are generalizable to patients' daily functioning. To date, only a few studies have been concerned with the impact of cognitive training in domains other than cognition. Here we look at affective state, the perceived functionality and quality of life, for three different cognitive rehabilitation programmes.

Methods. Fifty-one AD patients in the mild stage of the disease were selected for the study and were randomly assigned to one of three cognitive training groups: 1) Memo+ (a paper and pencil memory training program); 2) SenseCam (wearable camera used as a passive external memory aid); 3) Written diary (a personal journal, used as control condition). All patients attended eleven sessions, twice a week, of one-hour length. We examined mood, perceived functionality and quality of life, before the intervention, one week after and at six months follow up.

Results. After treatment, the SenseCam and Memo+ groups had significantly reduced depressive symptoms compared to the Diary control condition. The same was found for measures of perceived functional capacity, but quality of life measures yielded less clear results. Despite significant changes immediately after the training period, we found little or no improvements in wellbing on our measures at follow-up.

Conclusions: Our results suggest that two types of memory rehabilitation can improve mood and instrumental activities of daily living. Thus, as well as yielding cognitive benefits, memory training programmes can yield significant improvements in self-report measures of well-being, at least in the short scale.

Keywords: Alzheimer's disease, SenseCam, Depression, Quality of life, Functional capacity.

2.2.1. Introduction

Alzheimer's disease (AD) represents a major challenge for healthcare as it includes a set of symptoms that contribute to poor perceived quality of life for these patients. The progressive deterioration of memory function is one of the core symptoms of this disease and one of the most disruptive in the mild stages (Jahn, 2013). In particular, the deficits in autobiographical memory (the memory for personally experienced events/general information related to the maintenance of the self) contribute significantly to this disruption, due to their close relationship with self and identity. The progressive decrease of memories that support the person's self-concept influences patients' well-being (e.g. Seidl et al., 2011). As such, memory deficits are often associated with non-cognitive symptoms frequently identified by patients with AD and their carers, such as anxiety, depressive mood, apathy, and decline in functional abilities. Such symptoms tend to appear progressively since the "pre-clinical" phase of the disease (Baquero & Martin, 2015). This combination of cognitive, affective and functional impairment often leads to a burden for both the patients and their caregivers, caused by the “excess disability” of the AD patient (Bahar-Fuchs et al., 2013).

Reviews concerning pharmacological and non-pharmacological interventions that delay or compensate for the clinical decline of patients with AD routinely consider non-cognitive symptoms as important as the cognitive deficits. However, the focus has tended to be on cognitive symptoms and cognitive effects of interventions (e.g. Bahar-Fuchs et al., 2013), even if researchers and clinicians consider that interventions are only effective if they target the full spectrum of symptoms (e.g. Huckans et al., 2013). In this article, we turn our attention to the effects of cognitive rehabilitation of patients in AD in measures of well-being and mood.

Non-pharmacological interventions, which include cognitive rehabilitation, aim to help AD patients at the beginning of the disease to manage its impact. They consisted, at first, of intensive sets of memory training sessions, aimed at stimulating specific cognitive functions. However, these first programmes were ineffective due to the substantial cognitive effort they required of the patients, particularly considering the cognitive abilities already impaired at that point of the disease (see Kapur et al. 2004 for an overview). The difficulty of such demanding tasks and the subsequent failures perceived by the patients contributed to an increase in dropouts, feelings of frustration and a decrease of motivation, both for the patients and their relatives (Logsdon et al., 2007). Some techniques, such as errorless learning, spaced retrieval and using vanishing cues are less demanding and more helpful for patients’ memory functioning (Clare et al., 2010). The challenge with such rehabilitation strategies is to transfer the improvements from laboratory based tasks and materials to real life situations; and in general the effects were circumscribed to specific measures and not generalized to daily functioning. Nonetheless, such cognitive rehabilitation has had impacts on activities of daily living and well-being when the rehabilitation has focussed on daily life tasks, such as re-learning how to use voice-mail, how to knit, or the names of members at a social club (e.g. Thivierge et al., 2008). As such, intensive and person-centred rehabilitation has been seen to influence patient well-being, but most of the work in this area has been reports of successful case-studies. Here we turn our attention to comparing an external memory aid with cognitive training, as well as using a group study.

External memory aids are based on the premise that one must, in an irreversible (so far) neurodegenerative disease such as AD, help patients to compensate for lost cognitive abilities. Consequently, aids such as diaries, journals, calendars, and wearable cameras, have been used in daily life (and not in lab conditions), and here there has been a more direct influence on patients' daily life. Some researchers argue that "compensatory therapy" has more potential than other cognitive interventions to help AD patients because of this close link to everyday function (Huckans et al., 2013). Additionally, the fact that some external aids do not require training to be used – so called "passive" cognitive aids – is less burdensome for patients. However, diaries, journals, and calendars, named "active" cognitive aids, require practice for their use to be effective (and much support from the caregiver to remind the patients for the need to use these aids).

Technological advances overcome some of the difficulties of the active external memory aids. As an example, wearable cameras such as SenseCam (Berry et al., 2007) are not cognitively demanding for patients, since they are just required to wear the camera and then passively review the collected images later. A review of the early work in using such devices to improve memory function, suggests that such devices mimic autobiographical memory function, and deliver measureable effects on memory performance, both for the contents of the days depicted in the images, and for memory function more generally (Silva et al., 2016). Critically, the experience of using SenseCam was described by patients with several neurological conditions (ex: temporal limbic encephalitis, Berry et al., 2007) as a pleasant experience, increasing self-confidence in memory function as well as reducing anxiety (Hodges et al., 2006; Berry et al., 2007; Loveday & Conway, 2011). These findings were also corroborated in De Leo et al. (2011) study, that adapted the paradigm of wearable cameras to a smart-phone and tested its effects in one AD patient. However, most of this data was collected by asking the patients and their carers about what they remembered and how did they felt, without structured and standardized measures. So far, from the studies that tested SenseCam as an external memory aid, only one study with healthy older adults tested subjective feelings about using SenseCam with objective measures (Silva et al., 2013). In this study, subjective feelings (ratings in a lickert based scale from score one to seven) on the following variables were measured: 1) vividness of events; 2) memory aid's ability to prompt additional memories; 3) surprise; 4) excitement; 5) felling of alertness; 6) value of the memory aid; 7) feeling of re-experiencing the events). Results in these measures were in line with the effects on cognition as tested by neuropsychological assessment instruments. As such, when the scores in standardized tests of memory, executive function, attention, increased, the ratings on the subjective variables increased.

Until now, only three studies using SenseCam as a memory aid examined some effects for patients with Alzheimer disease (Lee & Dey, 2008; Crete-Nishiatha et al., 2012; Woodberry et al., 2015). Of these studies, only Woodberry et al. (2015) have tested the efficacy of SenseCam with a group of 5 patients with AD for the ability to remember events depicted in the SenseCam images but also for their subjective experience. They found that the patients who benefited most from the camera by remembering more events/details of what was recorded were those who rated the experience of using the camera as more pleasant and helpful.

In sum, there is a need to consider and measure the impact of cognitive rehabilitation methods on quality of life, mood and the capacity to carry out daily activities, an emphasis which is clear in the pharmacological intervention literature.

Comparatively, the knowledge of how cognitive rehabilitation impacts on these critical entities is less well known. Critically, different types of rehabilitation may have different associated effects on well-being and mood. First, intensive memory training, whilst improving specific cognitive function, may not transfer to other activities, and may be perceived as a difficult, and time consuming activity. It may also upset patients by constantly challenging and testing their memory function. Second, more active external aids, such as keeping a journal, may also not lead to any real transfer, and again, they may be experienced as effortful, unenjoyable or not beneficial, although we would not expect them to upset or frustrate the patient in the same way as memory training. On the other hand, keeping a journal about recent events may support and maintain autobiographical memory function in a way memory training does not, and therefore it may have some positive effects on identity. Finally, passive external aids such as SenseCam, may offer some stimulation of memory without challenging or upsetting the user, and in turn, this method will also support autobiographical memory, and therefore the identity and well-being of the patient. We tested the impact of these three types of memory rehabilitation on various measures of well-being.

We report here the data pertaining to examine well-being from a research programme which has concluded that relative to a journal control condition, SenseCam and a comprehensive memory training program named Memo+ (see method section for description) improve episodic, semantic and working memory (Silva et al., submitted). These benefits were maintained until a six-month follow-up. SenseCam was particularly effective in improving autobiographical memory, compared with the other two interventions, which as we have evoked above, might lead to an increase in well-being through the maintenance of the self-concept. We might expect that any improvement in cognitive function would lead to improvements in the quality of life and well-being, since the literature suggests that the measures of non-cognitive variables such as mood, functionality, perceived quality of life are associated with the effects of cognitive interventions in cognition. This would mean that in this study, SenseCam intervention, as well as Memo+ intervention improve well-being in comparison to the Diary intervention. However, due to the nature of the three types of task, as we proposed above, we could also reasonably expect that the SenseCam group will have more of a positive impact on mood and well-being.

2.2.2. Methods

Participants

Sixty-seven patients with mild AD volunteered to participate in the study, but only fifty-one completed the full set of sessions of cognitive training they were assigned to (age range 62 to 80 years, *M* = 73.65, *SD* = 5.498). Inclusion criteria for the study were the following: diagnosis of probable AD, amnesic presentation (NIA-AA workgroup criteria); less than six-months since the diagnosis assignment; score between 15 and 26 on the Mini-Mental State Examination (MMSE); very mild (0.5) to mild (1.0) rates in terms of disease severity (Clinical Dementia Rating, CDR;) absence of severe symptoms of depression (Geriatric Depression Scale, GDS); community-dwelling or integrated in a day care centre; and cared by an identified caregiver willing to participate in the study. Table 1 describes the demographic characteristics of participants at baseline in the three cognitive intervention groups. We used the Addenbrooke Cognitive Examination – Revised test to screen in more detail general cognitive function. We also used the Portuguese version of the National Adult Reading Test – NART, (Teste de Leitura de Palavras Irregulares – TELPI) to examine the estimated premorbid IQ of the participants in the study. No significant differences between groups in any relevant sociodemographic variable were found as well as in overall cognitive function. Recruitment and cognitive training took place both at the psychiatric and neurology services of Coimbra University Hospitals (CHUC), at the Portuguese Alzheimer Disease Association (APFADA) and at the Home Care Rainha Santa Isabel, between January 2013 and October 2015.

Table 1. Demographic characteristics of the three cognitive intervention groups, at visit 1 (N=51)

	Memo+ ***N=17***	***SenseCam*** ***N=17***	***Diary (control)*** ***N=17***	***F*** (3, 48)	***P***
	Mean (SD)	*Mean (SD)*	*Mean(SD)*		
Age	71.71 (5.15)	75.41 (5.26)	73.82 (5.74)	2.02	.14
Years of education	5.18 (3.68)	4.76 (3.47)	6.76 (4.63)	1.21	.31
Mini Mental State Examination (MMSE)	21.53 (3.01)	21.88 (3.33)	22.82 (1.85)	.97	.39
Addenbrooke Cognitive Examination – Revised (ACE-R)	63.18 (7.67)	63.12 (7.47)	61.06 (8.25)	.41	.67
Estimated premorbid IQ (TELPI – Portuguese version of NART)	94.00 (13.38)	97.57 (12.03)	99.23 (15.41)	.54	.59
Clinical Dementia Rating – CDR	0.91 (0.19)	0.85 (0.23)	0.94 (0.16)	.85	.43

Design

This study was a pre-test/post-test/follow up controlled trial of three cognitive training interventions. This study was single-blind randomized trial; the participants were unaware of the nature (control/experimental) of the intervention they were taking part in. Participants were randomly allocated to receive either Memo+ training, SenseCam training or to complete a daily journal in the Diary control condition (see the Cognitive interventions section for description of the groups). Seventeen participants were assigned to each group. Neuropsychological assessment to collect data both on cognitive and non-cognitive measures was performed at baseline, one-week after the end of the interventions and at six-months follow up. For each group, the number of sessions was the same (eleven sessions, twice a week and one hour per session). All fifty-one participants took part in pre and post assessment sessions but only forty-six patients were in the follow-up visit.

The therapist that conducted all sessions of cognitive training for all participants in all groups was the first author of this paper.

The study procedures were approved by the research ethics board of the hospital (CHUC ethics approval number 4212) and by the direction of the remaining recruitment institutions, and we obtained written informed consent from all participants prior to the start of the study. No financial compensation was provided to the patients for their participation in the study.

Cognitive interventions

SenseCam Group. This group's cognitive training activities consisted of using SenseCam worn around the neck while freely performing routine activities, and the review, on a computer screen, with the therapist, the set of images captured by the camera. Participants were instructed to wear the camera for the longest possible time during the day but they were also informed of the possibility to remove or turn of the device at any event they wanted to remain private. Besides being asked to comment on the pictures they were watching, during the session partcipants did not receive any feedback from the therapist about the comments' accuracy.

Memo+ Group. We constructed a cognitive training program based on pencil and paper tasks to practice motivation, attention and memory, with progressive levels of difficulty throughout the sessions. The tasks included in this program were selected from research papers that described efficient strategies to stimulate specific cognitive abilities in patients with cognitive impairment (e.g., Arkin, 2001; Cherry at al., 2010; Choi & Twamley, 2013; Dun & Clare, 2007; Fish et al., 2010;). Besides having three exercises per session to practice cognitive strategies (like spaced retrieval, Lee et al., 2009, vanishing cues, Haslam et al., 2011, mnemonics, Hampstead et al., 2012, or errorless learning, Clare et al., 2010), each session ended with feedback given by the therapist concerning the participant's performance in each exercise.

Personal Diary Group (Control Condition). This control condition consisted of asking participants to write in a personal journal the activities or events experienced during the day, and to read those entries to the therapist during the sessions. To facilitate filling in the diary pages, the diary is organized in 5 sections (following the recommendations of Bourgeois, 2007): 1). event description; 2). time; 3). place; 4). people involved; 5). emotional state. A section for appointments and another for other notes was also included to offer help for future events record. Participants were instructed to fill the diary pages at the end of each day during the six weeks of the intervention, and carers were instructed to recall the participants about the need to fill the diary pages in case they don't perform that action by their own.

Non-cognitive outcome measures

Depressive symptoms

Depressive symptoms are the most common affective symptoms experienced by AD patients in the Mild stages of the disease (Baquero & Martin, 2015). We used the Geriatric Depression Scale – 30 to examine participants' mood (GDS-30). This is a 30-item scale with a yes/no response format, that allows to examine the presence of psychological and behavioural symptoms of depression, during the last week. It is specifically developed for the geriatric population, excluding symptoms related with other somatic diseases. The final score is the sum of symptoms. The scale allows us to distinguish the absence of depressive symptoms (score between 0-10 points), mild to moderate depressive symptoms (score between 11-20 points) and severe depressive symptoms (score between 21-30 points)).

Functional Status

We assessed the perception of participants in the study to perform routine activities of daily living, using the Adults and Older Adults Functional Assessment Inventory (IAFAI), a Portuguese inventory of functional incapacity assessment, specifically constructed for adults and older adults. The IAFAI includes both basic activities of daily living (BADL) and instrumental activities of daily living (IADL) to enable a comprehensive assessment of functional capacity. The 18 BADL items encompass four domains (feeding, dressing, bathing and continence, and mobility and transference). The IADL-familiar items encompass four domains (conversation and telephone use, meal preparation, housekeeping, and home security), and the IADL-advanced items encompass five domains (comprehension and communication, health-related decision making, finances, going out and transportation use, and leisure and interpersonal relationships). The inventory is administered in a structured interview format in order to determine for each item the functional capacity level.

Quality of Life

Quality of life is one of the measures more frequently tested when examining non-cognitive outcomes of cognitive training. As such, we applied to all participants the European Portuguese World Health Organization Quality of Life-OLD (WHOQOL-OLD) module, that consists of 28 items rated on a five-point scale covering 7 domains: Sensory functioning; Autonomy; Past, present and future activities; Social participation; Death and dying; Intimacy; and Family/family life (a domain that is only present in the Portuguese version of this module). Higher scores indicate better QoL.

Statistics

Analyses were conducted using the Statistical Package for Social Sciences 22.0 (SPSS 22.0; IBM SPSS, Chicago, IL). Data were examined and no outliers were identified. The distributions of data were examined using histograms, plots, and tests of skewness and kurtosis. All demographic characteristics and outcome measures followed normal distributions. Differences in the demographic characteristics between the groups were analysed using one-way ANOVAs. We also performed one-way ANOVAs to examine the differences between groups in the outcome measures at baseline, and the impact of cognitive training in those measures was analysed using 3 x 3 mixed design ANOVAs (with Group as the between subject factor and Visit as the whitin subject variable). Significant main effects and interactions were analyzed using pairwise comparisons, with Bonferroni's adjustment for multiple comparisons. The α value was set at .05 for all statistical tests, and at .01 for interactions. Differences in each training group performance in the outcome measures between baseline (Visit 1), immediately after training (Visit 2) and six months' follow-up (Visit 3) were analysed using paired samples t-tests. Setting the α for the study involved consideration of the fact that multiple comparisons were used on the same data in this study, which would generally lead to using a more conservative α to avoid Type I errors. However, the study also involved exploration of a new cognitive training interventions with a relatively small clinical sample. This meant that it was equally important to avoid Type II errors, possibly missing information about the potential effectiveness of the program. Therefore, no statistic adjustment was made for the multiple comparisons.

2.2.3. Results

We compared the group scores at baseline for outcome measures outlined above. One-way ANOVAs showed no significant pre-intervention differences between groups on any of the measures: Geriatric Depression Scale, F(2, 48)=.295, p=ns; Adults and Older Adults Functional Assessment Inventory, F(2,48)=1.68, p=ns; World Health Organization Quality of Life – OLD, F(2,48)=2.62, p=.09 (Table 2, for means and standard deviations). We will now describe the results in the noncognitive outcome measures applied to participants in this study concerning the effects of the three cognitive training interventions.

Table 2. Means, standard deviation and p values for group differences in the non-cognitive measures assessed

Instrument	**SenseCam**			**Memo+**			**Diary (control)**			Main effect of intervention (F)
	1 N=17	2 N=17	3 N=15	1 N=17	2 N=17	3 N=16	1 N=17	2 N=17	3 N=16	
Depressive Symptoms										
GDS (0-30) [a]	12.64 (6.25)	**6.79*** **(3.66)**	7.57 (4.03)	11.44 (4.62)	10.31 (5.12)	11.06 (4.50)	13.00 (5.29)	13.40 (5.22)	14.60 (5.12)	3.53 p=.03
Functional capacity										
IAFAI global (0-100) [b]	19.72 (7.74)	11.58 (8.18)	16.92 (8.36)	21.42 (11.54)	14.06 (7.54)	18.26 (9.64)	16.07 (5.96)	18.40 (7.42)	19.58 (7.32)	n.s
IAFAI basic	6.93 (7.22)	3.98 (7.08)	5.93 (7.42)	5.72 (7.59)	3.60 (4.43)	5.33 (7.06)	4.62 (3.66)	5.64 (4.26)	4.86 (4.22)	n.s.
IAFAI instr. FamiliarFamiliar	18.72 (9.96)	11.11 (8.26)	16.17 (8.90)	22.56 (16.62)	11.24 (5.96)	16.76 (12.07)	12.14 (5.36)	17.02 (11.28)	19.24 (11.67)	n.s.
IAFAI instr. Advanced Advanced	37.85 (15.02)	23.62 (13.81)	31.41 (17.85)	40.51 (14.30)	28.58 (12.62)	35.46 (13.45)	34.04 (15.91)	36.32 (14.06)	38.95 (12.71)	n.s.
Quality of Life										
WHOQOL-OLD (0-200)[c]	109.33 (15.64)	**116.47*** **(12.71)**	110,00 (16.73)	103.75 (12.86)	107.19 (11.26)	103.38 (10.28)	100.27 (10.34)	99.20 (9.66)	91.27 (24.67)	5.31 p<.01

[a]For this measure a higher score indicates higher levels of depressive symptomatology. Note that patients whose score was above 20 at baseline (meaning severe depressive symptoms) were excluded from the study.

[b]For this measure a higher score indicates the perception of higher levels of functional incapacity.

[c]For this measure, a higher score would suggest better perceived quality of life.

[*]Indicates the presence of a significant statistical difference to the control group

Depressive symptoms

A 3 x 3 mixed ANOVA was performed, with the cognitive training group as the between subjects' factor, in a total sample of 46 patients. A main effect for Group was found, $F(2,43)=3.53$, $p=.03$, $\eta^2_p = .14$. Fisher LSD post-hoc comparisons revealed that depressive symptoms as assessed by GDS were lower for the SenseCam group in comparison to the Diary group (p=.03), but no differences were found between the SenseCam and the Memo+ group (p=.51) and between the Memo+ Group and the Diary group (p=.26). A main effect was also found for Visit, $F(2,43)= 23.39$, $p<.01$, $\eta^2_p = .36$. LSD pairwise comparisons with Bonferroni adjustment identified lower scores in GDS in Visit 2 compared to both Visit 1 (p<.01) and Visit 3 (p<.01), and lower scores in Visit 3 compared to Visit 1 (p<.001), with an effect of the intervention in decreasing the depressive symptoms. Finally, an interaction was found for Group x Visit, $F(2,43)= 23.13$, $p<.01$, $\eta^2_p = .52$. After performing paired samples t tests to examine differences within each group between the visits, the SenseCam group showed a decrease of GDS scores at Visit 2 (M=7.24, SD=3.49) compared to Visit 1 (M=13.35, SD=6.02, $t(16)=7.93$, p<.01) but these increased significantly again at Visit 3 (M=7.73, SD=3.94, $t(14)=-2.07$, p=.02) although the mean at Visit 3 is closer to Visit 2 than Visit 1. The Memo+ group depressive symptoms scores revealed a significant decrese at Visit 2 (M=10.41, SD=4.97) compared to Visit 1 (M=11.88, SD=2.83, ($t(16)=2.21$, p=.04), but showed only marginal differences between Visit 2 and 3 (M=11.06, SD=4.51), t(15)=-1.91, p=.08, and no significant difference between visits 1 and 3, t(15)=.67, p=.51. The Diary group GDS scores did not change significantly after the intervention, with no differences found between Visit 1(M=12.76, SD=5.92) and Visit 2 (M=13.24, SD=6.05), t(16)=-1.93, p=.07, and there was even an increase in the scores at Visit 3 (M=14.60, SD=5.12), compared to both Visit 2, t(15)=-4.05, p<.01, and Visit 1, t(15)=.4.58, p<.01.

Functional capacity

The Adults and Older Adults Functional Assessment Inventory (IAFAI) yields a global score as well as scores for basic activities of daily living (ADL), instrumental-familiar ADL and instrumental-advanced ADL. We analysed as main outcome the global score. A 3x3 Mixed ANOVA found no main effect for Group, $F(2,43)=.29$, p=ns. A main effect of Visit was found, $F(2,43)= 16.26$, $p<.01$, $\eta^2_p = .28$, and LSD pairwise comparisons with Bonferroni adjustment showed that participants rated their level of incapacity lower at Visit 2 compared to Visit 1 ($p<.01$) but this returned to baseline rates at Visit 3 ($p<.01$), with no differences found between Visit 3 and Visit 1 (p=ns). An interaction of Group and Visit was found, $F(2,43)= 8.71$, $p<.01$, $\eta^2_p = .29$. It was found that for the SenseCam group the level of incapacity perceived by participants decreased after the intervention - at Visit 2 (M=11.51, SD=7.52) relative to Visit 1 (M=20.55, SD=8.64, $t(16)=7.75$, $p<.01$) but it increased again at follow up - Visit 3 (M=16.92, SD=68.36), compared to Visit 2, $t(14)=-3.58$, p=.17, returning to ratings closer to baseline – Visit 1, t(14)=1.64, p=.13. The same pattern was found in the Memo+ group, were the ratings of incapacity decreased at Visit 2 (M=13.63, SD=7.42) compared to Visit 1 (M=21.29, SD=11.19), $t(16)=5.23$, $p<.01$), but returned to the Visit 1 ratings mean at Visit 3, M=18.26, SD=9.62, $t(14)=1.72$, $p=.10$). The Diary group scores followed an different pattern to the other groups, with the ratings of perceived incapacity increasing after the intervention, at Visit 2 (M=18.89, SD=7.12) compared to Visit 1 (M=16.17, SD=5.63), t(16)=-3.08, p>.01, maintained stable at follow-up, the Visit 3 (M=19.59, SD=-7.33), with no differences found comparatively to Visit 2, t(14)=-.76, p=ns but increased scores compared to Visit 1, t(14)=-2.71, p=.02.

The IAFAI also provides partial scores for the basic ADL, the instrumental familiar ADL and the instrumental advanced ADL. As referred in literature (Sikkes et al., 2011), mild AD functional impairments are mainly related to instrumental ADL, mostly the more complex/advanced activities, whereas more severe stages of the disease show a progressive compromise of basic ADL. We analysed the ratings of the two instrumental ADLs. We analysed the ratings of incapacity for the Familiar IADL and the Advanced IADL. For the first score, no main effect for Group was found, $F(2,43)=.12$, $p=ns$. However, there was a main effect for Visit, $F(2,43)= 5.31$, $p<.01$, an effect described as relatively weak, $\eta^2_p = .11$. LSD pairwise comparisons with Bonferroni adjustment revealed than in Visit 2 participants perceived less incapacity for the familiar IADL than at Visit 1 (p=.01) and Visit 3 (p=.01), with no differences between Visit 3 and baseline Visit 1 (p=ns). There was an interaction between Group and Visit for familiar IADL, $F(2,43)=5.40$, $p<.01$, $\eta^2_p = .21$. Analysis of the means and additional paired-sample t tests for each group indicated the SenseCam group rates of incapacity for the F ADL were lower at Visit 2 (M=11.82, SD=8.63), compared to Visit 1 (M= 19.06, SD=9.11), $t(16)=4.91$, $p<.01$) and were maintained at Visit 3, with no statistically significant differences between these two time-points (M=16.17, SD=8.90), $t(14)=.80$, p=ns). The Memo+ the scores were lower at Visit 2 (M=11.05, SD=5.84) compared to Visit 1 (M=22,86, SD=16.14), $t(16)=4.96$, $p<.01$) but increased at Visit 3 (M=16.76, SD=12.07), $t(15)=-2.35$, p=.03), returning to the baseline level ($t(14)=1.79$, p=.09). In the Diary intervention, an opposite patern was identified, with the rates of incapacity in familiar IADL increasing after the intervention- Visit 2 (M=, SD=), t(16)=-2.55, p=.02 and remaining higher at follow-up, Visit 3 (M=, SD=), t(14)=-94, p=ns.

Concerning the advanced IADL, a similar pattern was found. No main effect of group was identified, $F(2,43)=.69$, $p=ns$, but a main effect of Visit was found $F(2,43)=11.74$, $p<.01$, $\eta^2_p = .22$ as well as an interaction effect for Group x Visit, $F(2,43)=4.83$, $p<.01$, $\eta^2_p = .19$. We again performed paired samples t-tests for each group across visits. The SenseCam group rated the items of Advanced IADL lower at Visit 2 (M=21.82, SD=13.10), compared to Visit 1 (M=39.17, SD=16.89), $t(16)=4.77$, $p<.01$)

increasing at Visit 3, (M=31.41, SD=17.85), $t(14)=-2.45$, p=.03), but to a lower level than baseline, f(14)=2.27, p=.04. In the Memo+ group, the scores for A IADLs were also lower at Visit 2 (M=27.41, SD=13.14) compared to Visit 1 (M=40.38, SD=13.86), $t(16)=4.67$, p<.01), and no significant differences between Visit 2 and Visit 3 (M=35.46, SD=13.45), $t(15)=-1.75$, p=.09). However Visit 3 scores are similar to baseline scores, t(15)=1.75, p=.10 for the Memo+ group. For the Diary group, no differences across Visits were identified for the A IADL scores, and if anything scores go in the direction of worsening activities of daily living (Visit 1 M=33.63, SD=15.13; Visit 2 M=36.86, SD=13.27; Visit 3 M=38.95, SD=12.71).

Quality of Life

We analysed the results of the World Health Organization Quality of Life – Older Aduls module (WHOQOL-OLD, Vilar et al., 2010). A 3x3 Mixed ANOVA identified a main effect of Group, $F(2,43)=5.30$, $p<.01$, $\eta^2_p = .20$. Fisher LSD post-hoc comparisons revealed that only the SenseCam group perceived QoL was higher than the control group - Diary (LSD, p<.01), with no differences detected between the SenseCam group and the Memo+ group (LSD, p=.26) neither between the Memo+ group and the Diary group (LSD, p=.21). A main effect of Visit was also found, $F(2,43)= 5.77$, p=.01, $\eta^2_p = .12$, and LSD pairwise comparisons with Bonferroni adjustment identified increased perceived QoL in Visit 2 compared to both Visit 1 (p=.01) and Visit 3 (p=.01), and no differences found between Visit 3 and Visit 1 (p=.52). However, no interaction effect was found for Group x Visit, $F(2,43)= 1.69$, p=ns, indicating that any of the interventions had a detached effect in the QoL scores.

2.2.4. Discussion

Whilst comparatively many studies have investigated the effect of cognitive rehabilitation programmes on cognitive function, there has been much less investigation into the impact of such programmes into non-cognitive outcomes, and very little using standardized measures. In the present study we examined three different cognitive programmes and their impact on wellbeing. The present study focussed, for the first time, on the effectiveness of a new wearable camera (SenseCam) to ameliorate mood, perceived quality of life and functional capacity in AD. This study was part of a larger research were a comprehensive neuropsychological assessment protocol was applied and the purpose here was to examine whether non-cognitive measures such as depressive symptoms, functional capacity and quality of life, were affected by the cognitive effects of these interventions.

With the Geriatric Depression Scale, we found that both SenseCam and Memo+ programmes lead to significant reductions in depressive symptoms, when tested immediately after the 11-sessions programme. The Diary control condition did not show such benefits. These reductions in depressive symptomology were not maintained at a longer term follow-up in either group, although there was a trend that depressive symptoms were lower than initially.

For functional capacity, for the total score we found the same pattern as for depressive symptomology, with the Memo+ and SenseCam groups showing clear benefits on activities of daily living. However, again, this pattern was not maintained at follow-up. The patterns are broadly the same for the subscores, clear effects of both Memo+ and SenseCam, but there is a suggestion that for the familiar IADLs these benefits may be retained to follow up in the SenseCam group, but not in the Memo+ group. In comparison, for the advanced IADLs, the Memo+ shows maintained benefits, and the SenseCam group shows somewhat maintained improvements.

Finally, for quality of life, there is a main effect of group, with the SenseCam group perceiving a better quality of life than the other groups, but in the absence of an interaction, it is difficult to attribute this difference to our intervention. Instead, with the significant main effect, we can interpret these data as showing that all groups benefit equally in terms of quality of life at the second time point.

Across these measures, we therefore find clear evidence of an impact of two of our memory programmes on measures of wellbeing, most notably depressive symptoms and functional capacity. The quality of life measure failed to yield any such clear patterns, although, as the means in Table 2 show, there is an improvement in QOL scores for the SenseCam group at the second visit. Perhaps most importantly, for no measure do we see an improvement in wellbeing for the Diary control group.

Thus we suggest that the SenseCam intervention contributes to improve mood but the effects are limited to the period in which the patients are actually using the device. All the effects of the interventions (even for the Memo+ in the functional status scores) were short term, not maintained at follow-up. It is interesting to set these data in the context on the changes of cognitive measures over the three visits. For neuropsychological test measures (Silva et al., submitted), there were approximately equal but significant benefits of the Memo+ and SenseCam programmes. In addition, there were maintained cognitive benefits of Memo+ and SenseCam at follow up, beyond the period of the training programmes.

First, these patterns indicate that SenseCam and Memo+ have similar effects on cognitive measures, and they also yield similar patterns for mood, perceived functionality and quality of life. Because SenseCam is the novelest rehabilitation tool used here, we will focus on discussing that aspect of the data. In short, although SenseCam does not have a unique beneficial effect on wellbeing as we hypothesised, it is, at least, in comparison with the Memo+ programme, much less cognitively demanding and requires much less input from a third party or professional, and in that way is a ‘passive’ memory aid.

This finding is in line with the research that suggests that wearable cameras are less demanding than other external aids that require training like the control group Diary and are also less demanding and more motivating than paper and pencil cognitive exercises. So, one can conclude that compensatory interventions for mild AD that resort on these kind of devices have more global effects than traditional interventions that only target specific outcomes. Wearable cameras like SenseCam are then powerful resources to improve well-being in mild AD. However, the conclusion that the effects are only immediate weakens, at least partially, the potentially of these interventions. Other studies have already mentioned that people, immediately after being tested with SenseCam, refer that the experience was pleasant, that they feel more confident and that it was helpful for their memory and for daily functioning (Berry et al., 2007; Loveday & Conway, 2011). However, in the studies people either saw images from SenseCam and then they were tested about their memory for those events in short and long intervals (Berry et al., 2007) or no long term effects were examined, so no data is available that examines longer term effects in subjective experience of patients.

Our findings, on the whole, were not maintained at follow up, with a return of our measures to baseline levels for most groups and most assessments. It is understandable, that the fact that, for six months, people were faced with no cognitive stimulation from any source, contributed for the loss of the beneficial non-cognitive effects. What is interesting is that cognitive benefits are, however, maintained over six months, suggesting that it is not directly the changes in cognition which lead to improvement in wellbeing, but rather the use of the device itself. The loss of some participants at follow-up could also contribute to these findings. Additionally, the fact that, for some of the measures (functional status, for instance), less clear data was found (no group effects, but interactions), might bring to the equation that the measures used to test these variables could not be adequate to test what they meant to test. In the case of the perceived functional status, we used an inventory no specifically built for the Alzheimer's disease functionality background. Thus, measures such as The Bayer Activities of Daily Living Scale (B-ADL) or the Alzheimer Co-operative Study – Activities of Daily Living (ADCS-ADL), are some of the measures developed specifically for patients with mild cognitive impairment or mild to moderate dementia considered to be more useful tools than general ADL measures for evaluation of treatment effects and the progression of the disease (Robert et al., 2010). Similarly, the quality of life instrument used in this study was also a general measure for geriatric population and not specific for AD, when several measures such as the Alzheimer Disease Related Quality of Life (ADRQL), the Dementia Quality of Life Instrument (DQoL) or the Quality of Life - Alzheimer's Disease (QoL-AD) were constructed considering the quality of life aspects more relevant for those patients. Additional to this methodological limitation, third person evaluation would also have been useful, at least for the functional status ratings and the present study did not address the caregivers' perspective (Loewenstein et al., 2004). Considering that, despite the patients tested are in the mild stages, they are probably no completely aware of their real abilities to perform the activities of daily living, and the perspective of a caregiver can be very helpful in this regard, although some confounding factors may arise and need to be taken in account, such as caregiver burden (Gitlin & Schulz, 2012).

Despite the methodological and sample size limitations of the present study, the findings are inspiring for future research. It is the first time SenseCam is tested with standardized measures in comparison with other cognitive interventions in a group of mild AD patients, homogeneous in terms of the main sociodemographic variables and severity of the disease. In the Woodberry and colleagues study (2015) where SenseCam was tested with AD patients concerning memory for events depicted in the images, the subjective experience was only examined by asking if they felt the camera as helpful, enjoyable to wear and see the images and if it made them feel more confident. In the present study we tried to examine a more global impact of this device in patients' daily life and we concluded that SenseCam is not only useful to stimulate cognitive function but also overall function (affective, functional) even in a neurodegenerative condition as AD. The apparent absence of long-term effects in perceived well-being of this device might indicate the need to apply this strategy as a non-pharmacological intervention for AD for longer periods than what we did in this study (six weeks). Future research should address this time-related hypothesis as well as to ameliorate the outcome measures and increase the sample size.

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3. Estudo 3 – Mnemonic anosognosia in Alzheimer's disease is caused by a failure to transfer on-line evaluations of performance: Evidence from memory training programmes

Submetido: Silva, A.R., Pinho, M. S., Macedo, L., Souchay, & Moulin, C. J., (submetido) Mnemonic anosognosia in Alzheimer's disease is caused by a failure to transfer on-line evaluations of performance: Evidence from memory training programs.

Abstract

There is a debate about the ability of patients with Alzheimer's disease to build an up-to-date representation of their memory function, which has been termed *mnemonic anosognosia*. This form of anosognosia is typified by accurate on-line evaluations of performance, but dysfunctional or outmoded representations of function more generally. We tested whether people with Alzheimer's disease could adapt or change their representations of memory performance across three different six-week memory training programmes. Using global judgements of learning, we showed that whereas online assessments of performance were accurate, patients continued to make inaccurate overestimations of their memory performance. This was despite the fact that the magnitude of predictions shifted according to the memory training. That is, on some level patients showed an ability to change and retain a representation of performance over time, but it was a dysfunctional one. For the first time in the literature we were able to use an analysis using correlations to support this claim, based on a large heterogenous sample of 51 patients with Alzheimer's disease. The results point not to a failure to retain on-line metamemory information, but rather that this information is never used or incorporated into longer term representations, supporting but refining the mnemonic anosognosia hypothesis.

KEYWORDS: Global judgements of learning, Metacognition, Dementia, Memory training

3.1. Introduction

Metamemory is described as the awareness of one's memory abilities, including judgments and knowledge about memory (Metcalfe, 2008; Shaked, Farrel, Huey, Metcalfe, Cines et al., 2014). Metamemory allows for the control and monitoring of self-initiated processes such that if someone makes inaccurate or inappropriate assessments of ongoing cognitive function, self-regulated learning will be suboptimal. Studies of metamemory processes have particular importance in effective care for patients with Alzheimer's disease (AD) because knowing how the impairment in memory is influenced by awareness, one may improve function with cognitive training and through feedback (Antoine, Nandrino, & Billiet, 2013; Clare et al., 2004, Green et al., 1993).

Metamemory can be operationalised as the relationship between subjective evaluations (predictions) and actual performance (see Ernst, Moulin, Souchay, Mograbi, & Morris, 2015 for review in Alzheimer's disease). In AD, the status of metamemory accuracy is currently under debate. Some studies point to a preservation of metamemory function (e.g,. Gallo et al., 2012; Lipinska & Backman, 1996; Moulin, Perfect, & Jones, 2000; Moulin et al., 2003; Waring, Chong, Wolkon & Budson, 2008;), whereas others point to a deficit (e.g. Barret el al., 2005; McGlynn, 1991; Shaked et al., 2014; Souchay et al., 2002). One way of thinking about this apparent contradiction in the literature is to think about the basis on which people make their metamemory predictions. Souchay (2007) pointed to a fractionation of metamemory based on the cues used to make the metamemory judgements. When the judgements rely upon an updating of beliefs about memory, there is a deficit: people with AD 'forget' that they have a bad memory, even though, on-line, in the middle of a task, they show appropriate awareness.

Metamemory is often referred to in relation to another term – anosognosia – that describes the clinical manifestation of unawareness of deficit (e.g., Vogel et al., 2005). A current debate in the field considers the extent to which metamemory and anosognosia can be differentiated (e.g., see Cosentino, Metcalfe, Butterfield, & Stern, 2007; Souchay, 2007). That is, can patients be simultaneously accurate in predicting their performance, but somehow unaware of their deficit? This idea is encapsulated in the fractionation of metamemory in Alzheimer's disease: anosognosia could arise because patients cannot build a realistic, up-to-date representation of their current level of metamemory function, even though they can adequately perform on-line tests of metamemory. In fact, Morris and Mograbi (2013) have offered just such an explanation of the relation between anosognosia and metamemory. They suggest that in Alzheimer's disease there is a *mnemonic anosognosia*, based on a failure to record the outputs from online monitoring processes and update representations of self-performance.

One manifestation of this deficit in updating representations of memory task performance in AD comes from the predictions of performance made before the opportunity to study. Several studies (e.g., Moulin et al., 2000) have shown that when first asked to make predictions of performance, people with AD make very inaccurate predictions, tending to overestimate their performance. In particular, initial predictions of performance, expressed as the number of items predicted that will be recalled on an upcoming test, tend not to be different from the predictions made by healthy controls (Thomas, Lee, & Balota, 2013). For many, this is *prima facie* evidence for a lack of deficit awareness in AD; predictions do not take into account that the person is experiencing memory loss. On the other hand, if multiple tests are carried out in the same session, or participants experience at first hand their memory abilities, their metamemory predictions are accurate; patients benefit from experience in their prediction accuracy – at least in the short term.

The idea is that any initial prediction on a memory task is not an informed judgement based on knowledge of a person's abilities or the characteristics of the upcoming test. It is not possible to know in advance how difficult a test will be, and so one must rely on generalised beliefs about performance (Connor & Dunlosky, 1992). The existing data suggests that these initial estimations are inaccurate and that they therefore reflect dysfunctional expectations about memory performance and anosognosia. However, one interpretation is that people with Alzheimer's and healthy controls merely have the same generalised beliefs about performance. Although this failure to update beliefs (see below) is taken as evidence of a form of anosognosia, this has seldom been directly tested. The best test of this idea is to see if, over time, people with Alzheimer's disease can build an accurate representation of the change in their memory function, which is what we test here. It seemed to us, the issue of whether patients can update their beliefs about memory lends itself to a longitudinal design, and in particular memory training. If we wish to measure the flexibility of patients' judgements, it would be good to manipulate in some way their function over time. In fact, we took an opportunistic approach, adding such metamemory measures to an ongoing programme of cognitive training. We expected that the initial predictions of performance should shift over time and according to the different levels of performance achieved in the memory training programmes.

Initial inaccuracy in AD has been most closely examined by Ansell and Bucks (2006) who looked at the ability to shift the initial prediction across several different tests. Ansell and Bucks tested a group of 18 AD patients. Participants were instructed to predict how many words they would be able to recall from a 10-word list. The list was then read by the experimenter and after hearing the list participants were again asked to predict how many words they would be able to recall (post-list prediction). Then the recall test took place and this whole procedure was repeated for two more different lists. Finally, after a short delay, participants were asked again to predict the number of words they think they would be able to recall if a fourth list was given (delayed-list prediction). The AD patients were, as expected, less accurate than controls in their initial prediction, before exposure to the materials, but revised their predictions after being presented the list, becoming more accurate across lists (but never reaching a comparable level to controls).

The pattern for the final prediction made after a delay is critical to understand whether the patients update their predictions or not, testing the idea of mnemonic anosognosia. Ansell and Bucks' data are difficult to interpret. Whereas the magnitude of the predictions made initially was significantly different between the first and third presentation of the ten-item list, the difference between the first and delayed lists only showed a trend (p=.05), and the difference between the delayed list and the third list was not significant (p=.10). The means in fact show the delayed prediction is somewhat higher than the third prediction, showing a return towards the very inaccurate first prediction, but this is difficult to interpret given the p-values reported, and the fact that, if anything, there is a trend for the judgement to be lower over the three versions of the test, and the delayed prediction is lower than the very first prediction. We aimed to address this issue with data over a longer delay, and where we could observe shifts in performance according to the improvement in memory performance.

In sum, the literature suggests that there are two forms of memory monitoring at play in metamemory judgments. First, initial predictions are made on the basis of generalised beliefs about memory function. The extent to which these predictions are accurate is shown in forward-looking predictions: someone who is metacognitively competent will make a prediction that relates well to subsequent performance. The second type of monitoring is on-line, and represents the capacity to be aware of on-going mental operations. This type of monitoring is seen in the relationship between prior performance and subsequent predictions: to what extent does performance on a previous trial become incorporated into predictions on the subsequent trial. We conceived this as a backwards-looking prediction. These two types of monitoring, operationalised as metamemory judgements made at different points in a series of verbal learning trials, were measured for the first time over a long time period (six weeks).

The current study was part of a much larger programme of research looking at memory rehabilitation in AD, and we took the opportunity to measure the two types of metamemory in relation to three different types of memory training. The fact that a well matched sample underwent several different types of memory training and was seen over multiple time points gave us the possibility to examine how knowledge and beliefs about memory might change over the course of a memory intervention, and how these may affect people's beliefs about their memory, and their initial memory predictions. Ansell and Bucks (2006) showed that initial predictions did not retain their accuracy over a delay, but we predicted that with the use of memory training, in particular, participants would be able to retain a more accurate assessment of their memory function (see Gross et al., 2012). In particular, we predicted that participants would be able to use feedback from the memory training and frequent visits from the experimenter to update self representations of performance. We predicted that between baseline and the final visit, we should therefore see a shift the initial first-list predictions.

3.2. Method

Participants

The sample consisted of 51 patients with mild AD (aged 62 to 80 years, *M* = 73.65, *SD* = 5.498) recruited from the Psychiatry and Neurology services of Coimbra University Hospital. Patients were recruited within 6 months of diagnosis being made according to the criteria of the NIA-AA workgroup (McKhann et al., 2011). The Addenbrooke's Cognitive Examination – Revised (Mioshi, Dawson, Mitchell, Arnold & Hodges, 2006) was used to establish a baseline of global cognitive function (*M* = 62.45, *SD* = 7.71). The study procedures were approved by the research ethics board of the Hospital Centre of the University of Coimbra (CHUC) (ethics approval number 4212), and all participants provided informed consent.

Table 1. Mean neuropsychological assessment battery and baseline results for the complete sample (N=51)

Neuropsychological instruments/tests	*SenseCam*	*Memo+*	*Control - Diary*
	Mean (SD)	*Mean (SD)*	*Mean (SD)*
Addenbrooke Cognitive Examination – Revised	63.12 (7.47)	63.18 (7.67)	61.06 (8.25)
Instrument for Assessment of Functionality for Adults and Older Adults (IAFAI)	20.55 (8.64)	21,.29 (11.20)	16.17 (5.63)
Verbal Fluency	55.65 (15.68)	56.88 (17.56)	46.41 (14.67)
Symbol-Digit Coding (WAIS-III)	15.12 (6.33)	19.24 (11.83)	20.59 (8.69)
Digit Span (WMS-III)	10.32 (2.60)	9.47 (1.66)	9.47 (1.00)
Pyramids and Palm Trees	39.06 (4.59)	42.82 (4.46)	40.41 (5.04)
Prospective memory task	3.24 (1.30)	3.18 (1.38)	3.53 (1.13)
Rivermead Behavioural Memory Test (RBMT) route task – immediate	8.24 (1.88)	8.76 (1.56)	8.47 (0.51)
Autobiographical Memory Test (AMT) total	15.76 (4.25)	16.41 (3.72)	17.88 (5.39)
World Health Organization Quality of Life questionnaire (WHOQOL-OLD)	108.88 (14.87)	102.94 (12.89)	98.76 (10.73)

The patients were randomly assigned to one of three groups of cognitive training (see below). These groups showed no differences in age, pre-morbid IQ and general cognitive status (see Table 1). One-way ANOVAs showed that there was no significant difference between groups for age, $F(2, 48) = 1.475$, $p = .241$, level of education (years of formal education), ($F(2, 48) = 2.340$, $p = .109$), estimated premorbid IQ (TELPI results on the Portuguese version of NART (Alves, Simões, & Martins, 2012), $F<1$), and general cognitive status (ACE-R (Mioshi et al., 2006) $F<1$).

Design and Memory Training Procedures

All three groups received memory training techniques which involved eleven visits from the same experimenter over a period of six weeks. The cognitive training groups were the following:

Memo+ Group. This program of memory training includes a set of exercises to practice motivation, attention and memory. The exercises have progressive levels of difficulty (either with increasing the number of items to retain, either increasing the retention intervals) throughout the training sessions and were based on studies that showed the efficacy of those techniques to stimulate memory in people with impairment (Arkin, 2001; Cherry at al., 2010; Choi & Twamley, 2013; Dun & Clare, 2007; Fish et al., 2010; Lee et al., 2009; Netto, 2010; Serrano et al., 2004; Sohlberg et al., 2000; Winter & Hunkin, 1999; Zanetti et al., 2001). The structure of each session was the following: a) orientation questions (date, place, one of the news read in the newspaper/seen of TV in that day); b) one exercise of attention (e.g., cancellation task counting the time– draw a circle around all X found in a page full of letters); c) one exercise of episodic memory (e.g., Shopping list with 5 items – spaced retrieval technique – recall 1 min, 3 min, 5 min, 12 min); d) one exercise of implicit memory/ functional activities (e.g., to perform the actions needed to send a letter to someone in a correct order); e) feedback given by the experimenter about each exercise (describing weaker and stronger areas of performance) f) at the end of the 11 sessions there was a questionnaire of self-assessment, where the patient was asked of the perceived gains from the training.

SenseCam Group. In this cognitive training, an automatic digital camera (SenseCam) was used to capture still images from participants' daily life, which were then shown on a computer during sessions with the experimenter. For a review of SenseCam use in memory impairment see Silva et al. (2016). Numerous studies have indicated that such use of a wearable camera can increase memory function (e.g., Berry et al., 2007, 2009; Brindley et al., 2011; Browne et al., 2011; Pauly-Takacs et al., 2011). The participant was instructed to wear the camera every day for as long as possible (from waking until the going to bed) in order to maximize the potential of the device and the number of images gathered. During the training sessions the participants reviewed their images and were asked to comment on what they saw. The experimenter did not ask questions or give feedback on the comments.

Personal Diary Group. In this group, participants were asked to write down their daily activities in a personal journal and to read the diary entries to the experimenter in each session. The Journal had organized sections to complete, by date, in order to facilitate filling in the of activities performed during each day, i.e. *Event description* (where the participant writes the activity done in that day, for example, *had breakfast with my partner*); *Time* (where the participant registers the time of the day the event took place, for example, *8 a.m.*); *Place* (where for each event the participant should register where the event took place, for example, *in a coffee shop around the corner*); *People Involved* (where the participant should describe other people that were part of the event described, for example, *my partner Lucy*); and *Emotional Description* (where the participant is asked to described how he felt during the event, for example, *relaxed and happy*). Two other sections were also included as aids for prospective memory: *Appointments* (to register appointments made in that day for future conclusion) and *Notes* (to register additional information such as current events seen on TV or a message given by some friend). The participant was instructed to fill the diary pages at the end of each day.

A comprehensive neuropsychological assessment was applied before assigning each participant for each memory training group, repeated immediately after the end of the training sessions and again six months after (See Silva et al., submitted). Table 1 presents baseline scores for each group in each test of neuropsychological assessment before the intervention. There were no significant differences between groups in any measure at this point. In addition to a sociodemographic questionnaire and the ACE-R for cognitive screening, participants performed several cognitive tasks, with special focus on verbal episodic memory – using word lists (Wechsler, 2009) – to which metamemory questions were added (see details below). Participants in all groups also answered some questions at the end of their training sessions to assess the perceived gains of the training. This was done using a 4-point Likert-scale type questionnaire that included the following questions: 1) How do you judge the quality of the sessions you took part during these 6 weeks? 2) Did the training sessions meet your expectations? 3) Did these sessions allow you to find help in what you needed? 4) Has what you have learned allowed you to manage your difficulties more easily? 5) Would you advise a friend with similar difficulties to take part in this kind of training? 6) If you had the opportunity, would you be keen to take part in more of these sessions? As some of these questions are metacognitive, we analysed the results of this general questionnaire in this paper.

Materials and Metamemory Task Procedure

The standard Wechsler Memory Scale – III (Wechsler, 2009) word list test was adapted to study metamemory judgments using global judgements of learning (gJOLs). In summary, this test uses 12 concrete unrelated words. There are four learning trials, where the experimenter reads the words in the same order and the participant is instructed to recall them immediately in any order. These trials are followed by an interference list (with a different 12 concrete and unrelated words) and by a short delayed recall task of the first list. After an interval of 20 to 25 minutes a long-delay recall is applied to the original list followed with a yes/no recognition task for the items from that list.

In the four learning trials of the Word Lists test, we added a gJOL measure, where the participants were asked, before being presented the list, to predict the number of words they will be able to recall after hearing the list. After the four trials´ gJOLs and recall, the participants were additionally asked to predict how many words they would be able to recognize later (not reported here). No feedback on performance was given. We gathered these data at baseline (before the beginning of cognitive training) and after memory training (approximately one week later) using identical materials. All 51 patients included in the study had complete data on all predictions and recall measures.

3.3. Results

The results section is organised as follows: First the actual performance in the Word Lists test of the three groups is considered, according to trial and to visit (baseline (Visit 1) versus post training (Visit 2)). The critical issue here is whether there has been any improvement in episodic memory performance over time in the three groups. Next, the magnitude of the gJOLs is analysed, following the same design. In these analyses, we are interested primarily in whether the gJOLs show a shift according to the type of memory training, and whether we observe the initial overestimate of performance which is typical of AD. This sensitivity analysis (cf. Moulin et al., 2000) will allow us to see if the patients are aware of the effects of the memory training and the repeated learning trials on their memory. The third set of analyses will, following convention, consider the non-directional discrepancies between memory performance and predictions, with the aim of seeing whether metacognitive accuracy is altered by the memory training procedures. A subsequent analysis will consider the correlations between variables to further analyse the relative accuracy of the global predictions (cf. Connor, Dunlosky, & Herzog, 1997). We will finish by analysing the results for the questionnaire of perceived gains carried out in the end of the memory training sessions for all participants, in order to assess the general beliefs in each groups of patients concerning the effects of the training in their cognition.

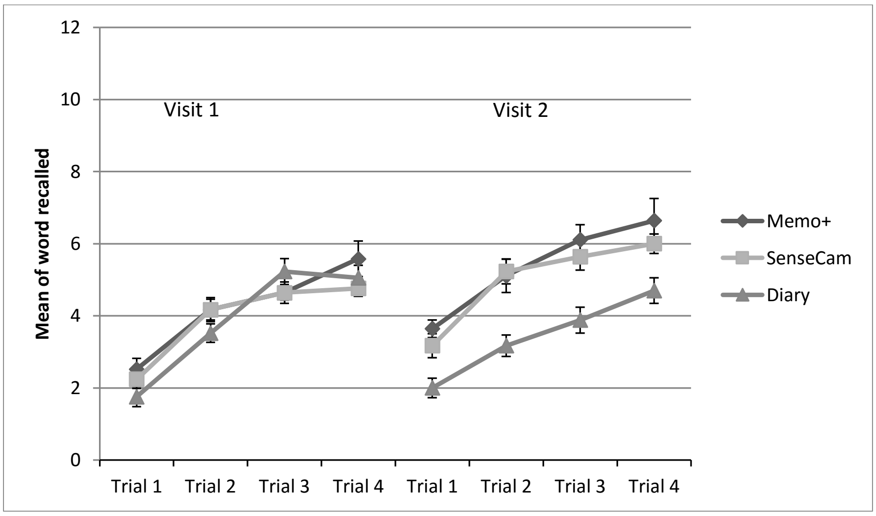

Figure 1. Mean Memory performance by group, in Visit 1 and 2, across trials. Error bars represent 1 standard error of the mean

- ***Objective memory performance***

A 3 (Group) x 2 (Visit) x 4 (Trial) mixed ANOVA with the cognitive training group as the between subjects factor was performed. A main effect of Group was found,

$F(2, 48) = 4.18$, $p < .05$, $\eta^2_p = .167$. Post hoc comparisons using the Fisher LSD test revealed that the MEMO+ group and SenseCam group do not differ significantly from each other ($p = .482$) whereas the Diary group shows a significantly lower performance than both the MEMO+ ($p < .01$) and the SenseCam ($p = .03$) groups. A main effect was also found for the time of assessment, $F(1, 48) = 23.85$, $p < .01$, $\eta^2_p = .332$, with a superior performance in Visit 2. There was also a main effect of Trial, $F(3, 48) = 147.06$, $p < .01$, $\eta^2_p = .754$, with increased recall across trials, as expected. There was a significant interaction between Group and Visit, $F(2, 48) = 20.21$, $p < .01$, $\eta^2_p = .457$). This is our critical analysis to see if groups' performance differed according to the memory training programme they carried out. Figure 1 shows that in the second visit the Memo + and SenseCam groups have different levels of performance from the Diary group, and moreover, the diary group shows little difference between Visit 1 and Visit 2. To examine this interaction further, we calculated the total recall score at Visit 1 and Visit 2 and submitted these scores to a 3 (Group) x 2 (Visit) ANOVA. Unsurprisingly, there was the same interaction, $F(2, 49) = 21.52$, $p < .01$, $\eta^2_p = .473$, but planned comparison t-tests showed that total recall increased significantly for Memo+ group, $t(16) = 4.82$, $p < .01$, and for the SenseCam group, $t(16) = 6.17$, $p < .01$, but it decreased for the Diary group, $t(16) = -2.81$, $p < .05$. Moreover, the difference between groups was not significant at Visit 1, $F(2, 48) = .509$, $p = .33$, but it was significant at Visit 2, $F(2, 48) = 10.89$, $p < .01$. No interaction effect was found for trial and visit, but a three way interaction was found between Group, Trial and Visit, ($F(6, 41) = 4.19$, $p < .01$, $\eta^2_p = .149$), suggesting that the different forms of training across visits differently influence the rate of acquisition of items in the memory tasks.

- ***gJOL Predictions***

Again, a 3 (Group) x 2 (Visit) x 4 (Trial) mixed ANOVA with group as the between subjects factor was performed. No main effect of group was found in the predictions, $F(2,48)=1.65$, $p=.20$), suggesting that, on the whole, participants in all three groups made comparable predictions of performance. A main effect was found for Visit, $F(1,48) = 40.63$, $p < .01$, $\eta^2_p = .458$, with the means indicating that participants make higher predictions on the second visit. There was also a main effect of trial, $F(3,48) = 32.94$, $p < .01$, $\eta^2_p = .407$), where people predicted being able to recall more words in the first trial compared to the other trials – Figure 2 shows a 'tick' shape curve for the predictions. There was a significant interaction between Group and Visit, $F(2,49) = 10.36$, $p < .01$, $\eta^2_p = .302$, indicating that groups change their predictions differently between the two visits (explored further below). There were not significant interactions between Group and Trial, nor Visit and Trial, F<1. The three-way interaction was however significant ($F(6,48) = 9.17$, $p < .01$, $\eta^2_p = .179$).

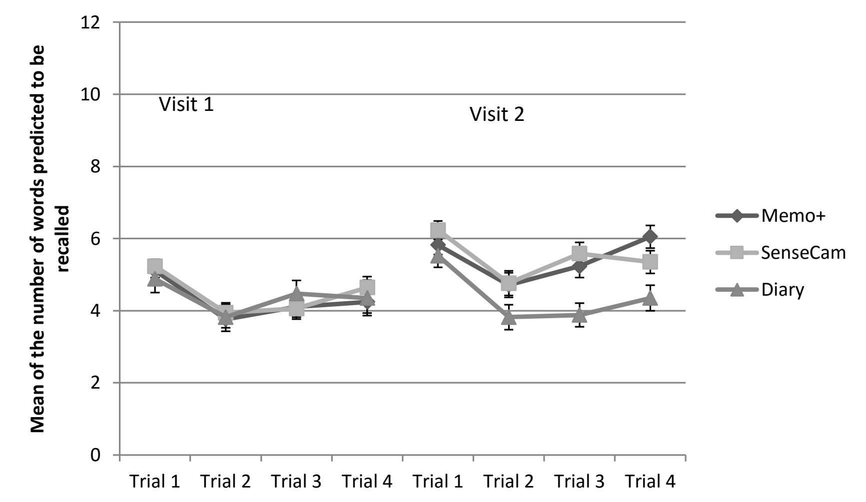

Figure 2. Mean predictions by group, in Visit 1 and 2, across trials. Error bars represent 1 standard error of the mean

In general, despite participants changing their predictions after memory training (in Visit 2) there are no significant differences between groups in how they make their predictions, even though there were differences in how the groups performed on the task. However, as has been demonstrated previously (e.g., Moulin et al., 2000), at both visits, participants made predictions on the first trial which were inappropriate. Mean predictions for the first trial ranged from 4.88 to 6.23, but mean performance was never higher than 3.64 for any group on the first trial of any test. This indicates that participants greatly overestimate their performance before starting the memory test. This can be explained by the absence of feedback in the first trial (there is no previous recall to rely on to make the prediction). Since we suggest that the predictions on the first trial have a different basis to the predictions made for the subsequent trials, we examined this pattern further by separately analysing Trial 1 in one analysis and the subsequent trials in a separate analysis.

A 3 (Group) x 2 (Visit) ANOVA examined the first trial gJOLs. No main effect of Group was found, $F(2,48) = 1.01$, $p = .37$. We did find however a main effect of Visit, $F(1,50) = 23.02$, $p < .01$, $\eta^2_p = .32$, where people predict being able to recall marginally more words after training ($M = 5.86$, $SD = 1.20$) compared to before training ($M = 5.07$, $SD = 1.26$). No interaction was found between Group and Visit, $F < 1$. These results suggest that the first prediction is not influenced by which memory training group participants were assigned to. However, overall, the participants make predictions which are significantly higher after having had any form of memory training.

We performed a 3 (Group) x 2 (Visit) x 3 (Trial) mixed ANOVA with group as the between subject factor on the gJOLs for the final three trials. No main effect of Group was found, $F(2,49) = 1.62$, $p = .21$, suggesting that the magnitude of predictions, on the whole, did not change according to the intervention used. We found a main effect of Visit,

$F(2,49) = 9.61$, $p < .01$, $\eta^2_p = .324$, with participants predicting being able to recall more words in Visit 2 ($M = 5.11$, $SD = 1.15$) than in Visit 1 ($M = 4.39$, $SD = 1.09$). There was also a main effect of Trial, $F(2,49) = 20.68$, $p < .01$, $\eta^2_p = .324$, where participants increase their predictions across trials (Trial 2 $M = 4.13$, $SD = 1.20$; Trial 3 $M = 4.55$, $SD = 1.08$; Trial 4 $M = 4.83$, $SD = 1.33$). We found an interaction for Visit and Group, $F(2,48) = 13.38$, $p < .01$, $\eta^2_p = .358$. No interaction for Trial and Group nor for Visit and Trial were found, F<1. The three way interaction was significant, $F(5,41) = 4.49$, $p < .01$, $\eta^2_p = .158$. The interactions with group point to a pattern whereby predictions resemble the pattern for performance. Figure 2 shows that all predictions are the same for the first visit, but that at Visit 2, the Memo+ group and the SenseCam group predict performance which is higher than the diary group. That is, whereas the diary group continue to make predictions at the same level as in the first visit, the other two groups increase their levels of prediction. Importantly, this is the same pattern as for actual performance.

- ***Prediction accuracy***

We operationalized the accuracy of the gJOLs as the unsigned difference between the number of items predicted and the number of items correctly remembered (Hertzog et al., 1990; Moulin et al., 2000). Figure 3 represents the accuracy curves across the four trials of recall, both before (Visit 1) and after the intervention (Visit 2), for the three intervention groups (Memo+, SenseCam and Diary). Figure 3 shows that participants are on the whole very inaccurate on the first trial, with predictions which are, on average, between 2 and 4 items different from actual performance.

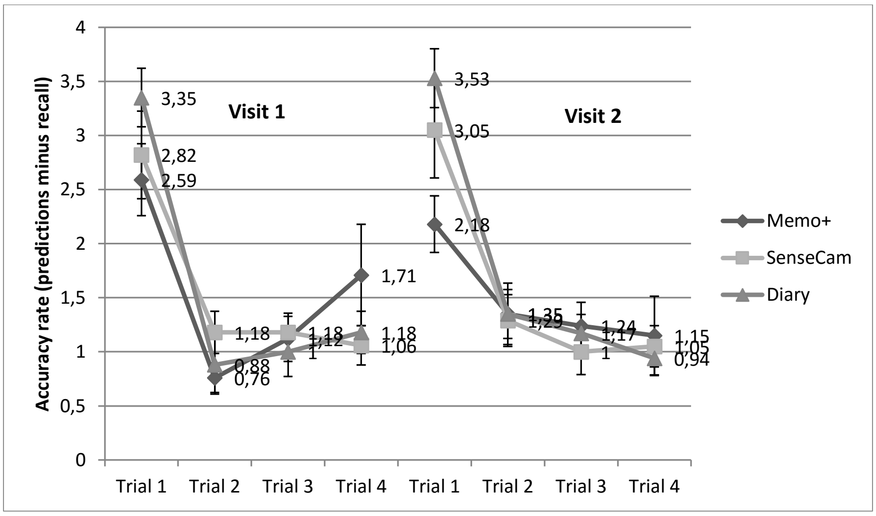

Figure 3. Accuracy of metamemory predictions. Mean (and standard error) unsigned difference scores by Group, in Visit 1 and 2, and across trials

Given this pattern, we again decided to examine accuracy separately according to Trial, with Trial 1 and Trails 2, 3 and 4 analysed separately. A 3 (Group) x 2 (Visit) mixed ANOVA was conducted for Trial 1. We found no main effects of Group nor Visit, $F<1$, and also no significant interaction was found for Group and Visit, $F<1$, indicating that accuracy in the first trial is not influenced by the kind of memory intervention used for improving objective performance. The mean unsigned difference between prediction and performance varied between 2.18 to 3.53. By way of comparison with other published studies, Moulin et al. (2000) found these initial predictions to have accuracy scores of between 1.94 and 4.37. Ansell and Bucks (2006) report a signed difference score of 2.75 for these first predictions. In short, there is no change in accuracy of these initial accuracy judgements according to the type of memory training procedure, nor over time. Moreover, these inaccurate overestimations of performance are in keeping with the published accuracy scores in previous studies.

A 3 (Group) x 2 (Visit) x 3 (Trial) mixed ANOVA with Group as a between subjects factor was conducted. We observed no main effects of Visit, Trial or Group in these accuracy rates, $F < 1$, suggesting that, as for the first trial, the accuracy for the subsequent trials is not affected by any memory intervention programme. We found one significant interaction between Visit and Trial, $F(2,49) = 5.59$, $p < .01$, $\eta^2_p = .102$, with the means suggesting that in Visit 1 people show poorer accuracy across trials (the scores move further from 0, the perfect accuracy rate), whereas in Visit 2 participants become more accurate across trials. In short, we found no differences in the accuracy of predictions according to group, suggesting that, during the task, regardless of group, participants all have the same access to information on which to make accurate predictions.

- ***Correlational analysis***

In order to examine the accuracy of the groups' predictions as a whole we analysed the correlations between the predictions (gJOLs) and the recall. The rationale for this analysis is that groups which are on the whole metacognitively accurate will show reliable correlations between their predictions and performance. As an example, across several experiments, Connor et al. (1997) found a correlation of up to $r = .66$ between predictions and performance in groups of around 40 healthy older adults. They found a pattern of correlations which changed according to when the prediction was made. Participants predicted their performance before study, between study and test and after test. Correlations were lowest (and actually negative) for the predictions made before test. Given the accuracy data above, we might expect to find little correlation between gJOLs and performance in the first trial, but which improves over trial. Our sample size of 51 permits, for the first time, this kind of analysis in AD. However, because our between-subject manipulation influenced recall at the second time point, we restrict our analysis to the first visit.

Table 2. Uncorrected correlations between predictions and recall, for the complete sample of AD participants in the study, at Visit 1 (r values, n=51)

	Recall Trial 1	Recall Trial 2	Recall Trial 3	Recall Trial 4
Prediction Trial 1	.037	.002	.008	.273
Prediction Trial 2	**.584****	**.460****	**.425****	.246
Prediction Trial 3	**.365****	**.311***	**.492****	.176
Prediction Trial 4	**.491****	**.469****	**.425****	**.395****

**. Correlation is significant at the 0.01 level (2-tailed, uncorrected).

*. Correlation is significant at the 0.05 level (2-tailed, uncorrected).

Table 2 shows very little relation between the predictions made before studying the list and the recall on the first trial, r = .037, in line with the idea that these initial first trial predictions do not capture recall performance. However, after this initial inaccurate prediction, as a group, people's predictions are reflective of their actual performance. There were strong correlations between performance and prediction across the subsequent trials, shown on the diagonal, with r values between .395 and .492. This analysis confirms the pattern in healthy groups by Connor et al. (1997).

One can also consider the correlations between recall in one trial and predictions in the next: this looks at how performance on the trial before is used in the subsequent prediction. Table 2 shows that all recall trials are significantly correlated with the subsequent prediction, from the first to the fourth trial (for example, Trial 1 recall correlates with the prediction on Trial 2, r=.58, p < .01). This brings additional evidence for the theory of online monitoring, obtained by the feedback participants get from previous trial's performance that contributes to an adjustment of predictions across trials.

- ***Perceived gains of memory training***

A questionnaire of perceived gains was carried out with all participants. For the six questions of this questionnaire a 4-point Likert scale was used. A higher score indicated that participants generally evaluated the training sections more positively. Table 3 presents the means and SD for this questionnaire. We analysed the total score for the complete questionnaire. A one-way ANOVA, showed group differences, $F(2,48) = 16.64$, $p < .01$). Post-Hoc analysis using the Fisher LSD test revealed that the MEMO+ group and SenseCam group do not differ significantly with each other ($p = .452$) whereas the Diary group shows a significant difference to both the MEMO+ ($p < .01$) and the SenseCam ($p < .01$). Participants that took part in SenseCam and Memo+ training conditions perceived the sessions more positively than the Diary groups, which is in line with our finding that the magnitude of gJOLs increases according to the memory training.

Table 3. Mean scores (and standard deviations) on the questionnaire of perceived gains, for each cognitive training group

	Memo+	SenseCam	Diary
1) Quality of sessions (min-1, max-4)	2.65 (.72)	3.06 (.66)	2.18 (.64)
2) Meet expectations (min-1, max-4)	3.18 (.64)	3.35 (.59)	2.12 (.86)
3) Helpful (min-1, max-4)	3.29 (.69)	3.06 (.75)	2.29 (.59)
4) Management of difficulties (min-1, max-4)	3.06 (.56)	3.24 (.56)	2.35 (.70)
5) Advice others to participate (min-1, max-4)	3.41 (.51)	3.41 (.51)	2.65 (.70)
6) Take part in future sessions (min-1, max-4)	3.29 (.47)	3.53 (.51)	2.76 (.75)
TOTAL SCORE (min-6, max-24)	18.88 (2.93)	19.65 (2.85)	14.35 (2.89)

3.4. Discussion

This study aimed to examine two patterns of metamemory performance found in patients with AD, but for the first time in the context of memory training: first, the inaccuracy and inflexibility of initial predictions; and second, the ability of AD patients to correctly monitor their memory online. Our rationale was that memory training might lead to shifts in memory performance over time that would enable us to examine whether similar shifts occur in prediction levels, and whether memory improvement leads to increased metamemory accuracy (especially for these deficient first predictions). Secondly, we took the opportunity to measure two initial predictions with a long time period (seven weeks – six weeks of memory training plus one-week interval between the end of the training and the post intervention assessment visit) between them. We were interested in whether any gain in accuracy of predictions be maintained across this period, especially given that patients were being reminded about their memory function throughout this period.

Most importantly, two of our three memory training programmes were successful in their aim. For free recall, across trials, the SenseCam group (passive memory training) and the Memo+ group (paper and pencil intensive memory training with feedback) had superior performance compared to baseline and compared to the Diary group. The first critical question was whether the prediction magnitude would be sensitive to such shifts in performance. The second critical question was whether the improvement in memory and involvement in a memory training programme might lead to more appropriate predictions of performance made before the first trail.

Focussing on the magnitude of predictions made by participants on the first trial, we found no group differences, and no interaction with group: on average, participants merely predicted higher recall on the second visit than at baseline. These mean predictions were all overestimations of performance. In short, before the first trial of the first memory test, participants overestimate their performance. After six weeks of training, the second time that they receive the test, they judge that their memory will be better than the first time. That is, they continue to overestimate their memory function. This is somewhat difficult to interpret because on the one hand, as their predictions shift upwards, so does performance (at least in two of the groups), which suggests some sort of relative metacognitive awareness. On the other hand, given their actual performance, the magnitude of these predictions, to be accurate, should shift downwards, not upwards. This is thus indicative of a metacognitive failure. The correlational analysis and results of our post-intervention questionnaire help clarify this picture. The lack of a correlation between predictions and performance suggest that these initial predictions do not access memory performance evaluations in a meaningful way. Secondly, the questionnaire findings point to a generally positive evaluation of the memory training (in the groups where it worked).

In sum, these first predictions can be taken as reflecting expectations of memory function that do not reflect idiosyncratic access to actual memory abilities, and that do not change over time. We found that these first trial evaluations were inaccurate and remained inaccurate over time. Even where we were able to improve memory function, and where we provided feedback during the memory training programmes, we were not able to influence the accuracy of people's initial predictions. The second time participants made a first trial prediction they seemed to add a just fixed amount to the prediction they made for the first time they encountered the test. From a clinical perspective this study suggests that asking predictions of performance before performing a test is not a suitable means of gathering information about metamemory function. Although, of course, it remains to see whether these inaccurate initial predictions, whilst not being predictive of performance, may actually be related to real world memory or learning behaviours which might be of interest to clinicians.

From a theoretical viewpoint, at first glance, these data challenge the idea that it is a mnemonic anosognosia that is behind Alzheimer's patients' inability to update their predictions over time (Ansell and Bucks, 2006; Souchay, 2007; Morris & Mograbi, 2012). The fact that predictions shift significantly upwards over time points to the fact that a representation of changed performance has in fact been made and retained (and this is based on internal representations because we only see this shift in the two groups which actually did show some improvement according to the training given). Unfortunately, however, this representation is not accurate, and the revision is in the wrong direction for it to be judged as metacognitively accurate. Thus, whilst it appears people with Alzheimer's are able to update retain representations about performance in the long term, they are unable to translate what they have learned during a task into more accurate first-trial predictions of performances. We might describe this as an ability to transfer on-line metamemory evaluations into meaningful generalised beliefs about an individual's memory function. Although some beliefs about memory can be updated and retained, information gained in the course of doing a task is not incorporated into the kind of long-term representations that are tapped in these initial first list predictions. Given that we find inaccurate pre-study predictions in healthy groups (Connor et al., 1997; Moulin et al., 2000) we might argue that this lack of transfer is not particular to AD.

Turning to the predictions made on-line, where the participants have had a chance to experience one round of study and test on the word list, we find, as with previous studies, that people with AD make more accurate predictions of performance. The magnitude of the gJOLs made increased significantly across trials as memory function improved. In terms of accuracy, we found that accuracy did not change according to trial or group, and that accuracy was approximately a discrepancy of 1 item. This is in keeping with published discrepancies on similar tasks (e.g. Moulin et al., 2000, Experiment 2, M = 1.50 (Alzheimer's disease), M = 1.68 (Healthy older adults). Thus our study adds to the data that suggests this form of on-line global evaluation of memory is not impaired in AD. This is one area of metamemory where people with AD show intact performance. Over six weeks, it was not possible to improve this level of performance, and the graph, and comparison with previous results suggests that in fact we may just show a ceiling effect for these data. This idea of accurate on-line monitoring was borne out in the correlational analysis. For the first time, we were able to show that the recall of a subsequent trial correlated with the prediction for the upcoming trial. This can be taken as showing that information from prior performance informs subsequent predictions. This is in line with published studies showing that retrospective judgements about memory performance are accurate in AD (e.g., Moulin, James, Perfect, & Jones, 2003).

Conclusion

We find that whereas predictions made within a task are accurate and shift according to changes in memory function brought about by memory training, the initial first-list predictions of performance do not show such accuracy. Although predictions of performance shift in line with changes in performance, i.e. patients predict that their memory performance will be improved after their memory training; this shift is in the wrong direction when we compare it to actual performance. That is, initial predictions of performance in AD fail to incorporate information from on-line monitoring, and continue to be gross overestimations of performance. We suggest that this represents a failure to transfer online information into crystallised representations of subjective performance, rather than an inability to update or remember information about memory performance in the long term. Whereas representations of performance *did* change during our six-week interventions, accuracy of these initial predictions did not improve. According to the leading theory in this domain, the Cognitive Awareness Model (Morris & Mograbi, 2013), this would be due to a failure to transfer information from on-line awareness into long term representations, which Morris and Mograbi describe as *mnemonic amnesia*. However, our data suggests that this failure to transfer my not be about memory per se, since some change in self-representation appears to be registered and retained, and not forgotten. Instead it seems that initial pre-study predictions and subsequent on-line evaluations measure different capacities, and there is very little incorporation of the latter into the former. The extent to which this is the case even in healthy populations is a priority for research into metamemory, where there are very few longitudinal studies of this nature. For clinical groups, our research explains why many patients set dysfunctional goals in rehabilitation settings: initial uninformed predictions do not take on board recent experiences of memory function. The fact that in two of our training programmes patients did show a shift in their prediction values means that it is not impossible that some rehabilitation procedure could help patients with AD incorporate feedback from performance into their metamemory judgements and retain it in the form of realistic expectations of performance.

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DISCUSSÃO INTEGRATIVA

"A especialização própria da tecnologia comporta grande dificuldade para se conseguir um olhar de conjunto. A fragmentação do saber realiza a sua função no momento de se obter aplicações concretas, mas frequentemente leva a perder o sentido da totalidade, das relações que existem entre as coisas, do horizonte alargado: um sentido, que se torna irrelevante. (...). Uma ciência, que pretenda oferecer soluções para os grandes problemas, deveria necessariamente ter em conta tudo o que o conhecimento gerou (...)."

(Jorge Mário Bergoglio, Papa Francisco)

Na presente secção afigura-se apresentar os motivos (com relevância científica e prática) que justificaram o desenvolvimento desta investigação para, em seguida, articular, fielmente, as expectativas e resultados esperados com os resultados efetivamente obtidos. Apresentaremos sumariamente uma discussão global dos resultados obtidos (já discutidos em secção própria em cada artigo que compõe esta dissertação), integrados no universo teórico no qual os mesmos se inserem, e nos seus contributos para o estado atual da arte e da prática no âmbito das intervenções não farmacológicas na DA. Concluiremos esta secção apresentando as limitações e as potencialidades desta investigação, aludindo a linhas de investigação futuras que visem o colmatar das limitações e o aprofundamento do conhecimento que este estudo permitiu principiar.

Dissertar sobre a qualidade e os rumos futuros de aprofundamento e melhoramento dos frutos de uma investigação exige, de modo a que se compreenda o caminho investigacional percorrido, retroceder ao ponto em que é tomada a decisão do tema sobre o qual queremos aprofundar o conhecimento. O dinamismo (avanços, retrocessos, bloqueios, mudanças de direção) de que é feita uma investigação científica obriga a compreender o ponto de partida, para que se possa, retamente, avaliar os seus frutos. Assim, vamos rever de forma breve esse ponto de partida.

A prática do psicólogo com pacientes com DA encontrava-se, até muito recentemente, limitada ao apoio à decisão médica no diagnóstico, através de avaliações neuropsicológicas. Neste campo, e centrando-nos no caso de Portugal, reconhece-se amplamente o esforço e o rigor com que têm sido validados instrumentos para a população idosa portuguesa sem e com declínio cognitivo, que se apresentam como ferramentas de extrema utilidade para a caracterização neuropsicológica, confirmação e diferenciação diagnóstica, e projeção prognóstica, no âmbito das condições neurológicas associadas ao envelhecimento. Desde instrumentos de rastreio cognitivo breve (Freitas et al., 2011; Simões et al., 2011), a questionários de avaliação da capacidade testamentária (Sousa, 2010), até a inventários de avaliação da qualidade de vida (Vilar, 2010), o papel do psicólogo que recorre a estes instrumentos na sua prática, neste contexto das doenças neurodegenerativas, encontra-se presentemente mais validado (e, consequentemente, mais valorizado) e as conclusões clínicas que daí extrai são mais robustas. No âmbito da experiência prática num contexto de intervenção psicológica geriátrica, reconhece-se a utilidade da avaliação neuropsicológica, inclusivamente no trabalho de partilha de informação com outros profissionais. Contudo, o alcance que a avaliação neuropsicológica *per se* permite, em termos do ato de ajuda e do ato terapêutico junto dos pacientes com DA, é restrito. Se, por um lado, o conhecimento obtido a partir da avaliação neuropsicológica compreensiva permite identificar as áreas fortes e fracas do funcionamento de cada paciente, não existem em Portugal, até à data e tanto quanto foi possível apurar, intervenções validadas pelo crivo da avaliação neuropsicológica que se ofereçam como resposta para os indivíduos com esta condição neurodegenerativa. Sendo os problemas de memória entendidos como *prima facie* da DA (e.g., Lyketsos et al., 2011), seria relevante que a sua identificação através da avaliação neuropsicológica se repercutisse na implementação de intervenções de estimulação da memória, por exemplo. A carência de opções de atuação com estes pacientes, aliada à observação do impacto que os défices cognitivos têm no bem-estar destes e da sua rede (cuidadores formais e informais) justificou, do ponto de vista da relevância prática, a presente investigação. Por outro lado, do ponto de vista da relevância científica, a literatura apresenta resultados dispersos e, em alguns casos, contraditórios relativamente às intervenções psicológicas na DA e à sua eficácia a curto e a longo prazo, sendo evidente a necessidade de sintetizar e contribuir para aumentar o consenso e a qualidade dos estudos em torno das intervenções que se revelam verdadeiramente úteis para estes pacientes.

De um modo global, e não obstante a especificidade e o constrangimento temporal que este tipo de investigação contempla, os estudos que integram a presente investigação permitiram concretizar algumas das aspirações práticas e científicas que motivaram a sua elaboração. Do ponto de vista conceptual, os percursos de pesquisa conduziram à elaboração de uma revisão crítica do estado da arte das intervenções de estimulação cognitiva na DA (ver *Parte 1, Secção 1*) e, de uma forma mais aprofundada, do papel dada câmara portátil SenseCam na estimulação da memória (ver *Parte 1, Secção 2*). Neste âmbito, as sínteses críticas empreendidas permitiram alicerçar os estudos empíricos, quer no que respeita ao tipo de intervenções a ser examinado quer no que respeita aos métodos utilizados para avaliar a sua eficácia. Por um lado, perante o surgimento de uma ferramenta – a câmara SenseCam – referida na literatura (e.g., Hodges et al., 2006; Loveday & Conway, 2010) como promissora para compensar défices mnésicos, a tomada de consciência relativa à ausência de uma avaliação estandardizada da sua eficácia através de instrumentos de avaliação neuropsicológica, conduziu ao desenho do estudo sobre os efeitos imediatos da SenseCam no desempenho em testes neuropsicológicos (ver *Parte 2, Secção 1*). A observação de que os ganhos a partir da utilização da SenseCam como ajuda externa de memória eram passíveis de ser detetados por instrumentos de avaliação neuropsicológica abriu caminho a uma replicação parcial (uma vez que a maior duração da intervenção nos estudos clínicos permitiu alargar o número e diversidade de instrumentos de avaliação utilizados) destas medidas nos estudos principais sobre os efeitos da SenseCam no funcionamento cognitivo (ver *Parte 2, Secção 2.1*) e no bem-estar (ver *Parte 2, Secção 2.2*.) de pacientes com DA em fase inicial. Por outro lado, a constatação de que as estratégias internas e as estratégias externas são frequentemente analisadas em separado nos estudos empíricos sobre as intervenções cognitivas na DA (Bahar-Fuchs, Clare, & Woods, 2013; Buschert, Bokde, & Hampel, 2010; Woods, Aguire, Spector, & Orrell, 2012), motivou a elaboração do programa Memo+ enquanto estratégia interna potencialmente eficaz para ser comparada com a estratégia externa SenseCam, possibilitando a obtenção de resultados informativos relativamente à utilidade de três intervenções de estimulação cognitiva diferentes para estes pacientes: SenseCam, Memo+ e diário escrito. Por último, o facto de uma das intervenções proporcionar explicitamente feedback aos pacientes sobre o seu desempenho cognitivo no decorrer da intervenção (Memo+) justificou a realização do estudo complementar sobre a capacidade metacognitiva na DA inicial (ver *Parte 2, Secção 3*). Deste modo, procurou-se aprofundar a conceção segundo a qual as pessoas com DA, ainda que em fase inicial, apresentam anosognosia mnésica, i.e., evidenciam uma consciência diminuída relativamente às suas capacidades de desempenho de tarefas de memória.

De entre todos os resultados obtidos nos estudos supramencionados, consideramos relevante destacar os seguintes:

a. A visualização de imagens captadas pela SenseCam durante três dias contribui para melhorar a curto prazo o desempenho cognitivo de adultos saudáveis, por comparação com a utilização de um diário escrito

- No estudo, na Universidade de Leeds, de Silva e colaboradores (2013) (ver *Parte 2, Secção 1*) com jovens e idosos saudáveis recorrendo a um design intra-sujeitos, verificou-se que os resultados em provas de memória (Teste de Memória Autobiográfica, Williams & Broadbent, 1986; Teste de Aprendizagem Verbal de California, Delis, Kaplan, Kramer & Ober, 2000; e Memória de Dígitos, Escala de Memória de Wechsler, Wechsler, 2009) e de funções executivas (Fluência fonémica e Semântica, Mitrushina, Boone, Razani & D'Elia, 2005; Ordenação de Meses, Almor, Kempler, MacDonald, Andersen & Tyler, 1999) foram superiores, após três dias de utilização e visualização dos conteúdos

SenseCam, em relação à redação e leitura das entradas de um diário escrito durante o mesmo período temporal.

- Não obstante a maior parte dos resultados nas provas de avaliação utilizadas terem mostrado a manutenção das diferenças de desempenho entre os grupos etários, independentemente da intervenção (SenseCam ou diário), no Teste de Memória Autobiográfica (Williams & Broadbent, 1986) os idosos apresentaram um desempenho semelhante aos jovens após a intervenção de três dias com a SenseCam, expresso no efeito de interação encontrado nessa prova. Tal sugere que os idosos beneficiam especialmente da prótese mnésica SenseCam para estimular a sua capacidade de recordar informação autobiográfica, na qual estes sujeitos apresentam algumas dificuldades consideradas como normais no envelhecimento saudável.

b. Uma intervenção de seis semanas com recurso à SenseCam apresenta um benefício significativo e equiparado a uma intervenção da mesma duração, recorrendo a estratégias internas (Memo+) na otimização do desempenho cognitivo e do bem-estar global de pacientes com DA em fase inicial, sendo os efeitos em termos do desempenho cognitivo observáveis até seis meses depois.

- O estudo 2a (ver *Parte 2, Secção 2.1.*) apresenta os resultados de uma análise transversal com 51 pacientes com DA em fase inicial, tendo mostrado que a intervenção com a SenseCam e a intervenção com o programa Memo+ contribuíram para melhorar, imediatamente após a intervenção e seis meses depois, o seu desempenho cognitivo, avaliado por várias medidas de memória (Lista de Palavras, WMS-III, Wechsler, 2009; Tarefa do Percurso do RBMT-III, Wilson, Greenfield, Clare, Baddeley, Cockburn, Wason, & Nannery, 2000, tarefa de memória prospetiva baseada no tempo do CAMPROMPT, Wilson et al., 2005, e Teste das Pirâmides e Palmeiras, Howard, &

Patterson, 1992) e de funcionamento executivo (Testes de fluência verbal, Mitrushina et al., 2005, e Memória de Dígitos, Wechsler, 2009, embora relativamente a esta última as medidas em que estas intervenções revelaram efeitos não foram as mesmas). O efeito positivo destas intervenções é reforçado tendo em atenção o padrão oposto de desempenho apresentado pelo grupo de pacientes que participaram na intervenção de controlo (diário escrito), observando-se, neste caso, resultados inferiores na maioria das medidas utilizadas, logo após a intervenção e ainda decréscimo de desempenho que se acentua em algumas medidas após seis meses.

- O estudo 2b (ver *Parte 2, Secção 2.2.*) complementa a informação recolhida com os pacientes com DA no estudo transversal e entre sujeitos, apresentando informação que mostra que a intervenção com a SenseCam e a intervenção com o programa Memo+ contribuíram para a redução da sintomatologia depressiva imediatamente após o fim das intervenções, o mesmo acontecendo com a perceção de incapacidade funcional. Contudo, os efeitos positivos destas intervenções não se mantiveram quando avaliados após seis meses, embora se tenha verificado uma tendência para essa preservação. Na medida de qualidade de vida, dada a ausência de um efeito de interação, não é possível retirar ilações desta medida.

c. **A participação de pacientes com DA em fase inicial em intervenções de estimulação cognitiva não parece contribuir para otimizar a consciência destes relativamente às suas capacidades mnésicas, mantendo-se um padrão de anosognosia mnésica**

- O estudo 3 (ver *Parte 2, Secção 3*) apresenta resultados obtidos numa das medidas de avaliação neuropsicológica utilizada com o grupo de 51 pacientes com DA (Lista de Palavras da WMS-III), na qual os pacientes foram, antes e imediatamente após as intervenções, avaliados quanto à sua capacidade de recordação de informação aprendida (julgamentos de aprendizagem – JOLs). Tratando-se de um procedimento inovador no campo dos estudos sobre metacognição na DA, observou-se que, embora o desempenho objetivo na tarefa tenha mudado após a intervenção (registou-se um aumento do desempenho após o treino cognitivo no grupo de pacientes que foi sujeito à intervenção SenseCam e à intervenção Memo+), os julgamentos feitos pelos pacientes também se modificaram, mas não se aproximaram dos resultados objetivos obtidos, mantendo-se imprecisos.

- Os resultados neste estudo revelaram que o feedback transmitido aos pacientes na intervenção Memo+ (a única intervenção que contemplou, em cada sessão, comunicação explícita ao paciente relativamente ao seu desempenho na sessão) não é utilizado eficazmente, por estes pacientes, para aumentar o seu conhecimento quanto às próprias capacidades cognitivas. Embora os julgamentos que os pacientes fazem após a intervenção apontem para que os mesmos considerem que a sua memória melhorou, no entanto acabam por voltar a sobrestimar o seu desempenho, à semelhança do que manifestavam antes da intervenção ter lugar.

Após esta síntese dos principais resultados da presente investigação, importa averiguar implicações destes dados para os objetivos que definimos para a mesma.

Intervenções não farmacológicas para DA: que opções?

Um dos propósitos de relevância prática que foram definidos para esta investigação consistiu, como mencionámos, na avaliação de várias opções de intervenção não farmacológica que se pudessem revelar úteis para reduzir o impacto da DA para os próprios pacientes e seus familiares. Neste sentido, foi possível estabelecer um paralelo entre três intervenções que recorrem a estratégias diferentes de estimulação cognitiva, i.e., a intervenção SenseCam, que propõe uma estimulação que não exige explicitamente quaisquer habilidades da parte do paciente, a intervenção Memo+, que diz respeito a uma estimulação baseada no feedback e no envolvimento ativo e intencional de recursos cognitivos para a aprendizagem de estratégias com vista a mobilizar as capacidades cognitivas remanescentes e, por último, o Diário, sob a forma de uma prótese mnésica que exige uma atuação intencional da parte dos pacientes para que o seu uso possa ser eficaz. A comparação entre uma estratégia externa passiva (SenseCam), uma estratégia interna ativa (Memo+) e uma estratégia externa ativa (Diário) possibilitou, de forma consideravelmente pioneira atendendo ao estado da arte, equiparar, numa amostra homogénea de 51 pacientes com DA em fase inicial, a qualidade e quantidade de ganhos (cognitivos, emocionais e funcionais) oferecidos por estas estratégias. Neste sentido, pudemos concluir, para a amostra examinada, que uma ferramenta de estimulação passiva pode afigurar-se tão eficaz (e no caso específico da memória autobiográfica, mais eficaz) quanto um programa multitarefas de treino baseado em estratégias internas. Tal conclusão é reforçada observando o desempenho dos pacientes que participaram na intervenção considerada controlo (Diário), cujo desempenho, para um número significativo de medidas, diminuiu após o treino e esse decréscimo acentuou-se após seis meses. Este desempenho ao longo de três momentos de avaliação da intervenção que delineamos como controlo é igualmente relevante para assumir que, ainda que dois dos momentos de avaliação tenham sido próximos (antes da intervenção e imediatamente após a intervenção o intervalo foi de sete semanas), não se verificaram efeitos da prática que pudessem enviesar a interpretação dos resultados, atendendo à curva de desempenho descendente desta condição.

A eficácia da SenseCam e do Memo+ foi clara no que respeita ao desempenho mnésico. A solidez inferior no âmbito das medidas que avaliam outras funções cognitivas (e.g., funções executivas) pode estar relacionada com os seguintes aspetos: por um lado, o facto das medidas de avaliação das funções executivas não serem entendidas na literatura como medidas puras de avaliação dessas funções (tais medidas mais puras seriam medidas múltiplas, exigindo por isso o aumento do número de tarefas que avaliam estas funções; Kirova, Bays & Lagalwar, 2015) pode ter contribuído para a menor clareza dos resultados; por outro lado, o foco acentuado da maioria dos instrumentos na memória e das próprias intervenções (apesar de o programa Memo+ contemplar o treino atencional e motivacional, incidiu fundamentalmente no treino de subdomínios da memória (ver *Anexo 2*), e a SenseCam, bem como o Diário, são descritos na literatura como úteis nos défices mnésicos, não havendo referência aos seus efeitos noutros domínios) pode ter contribuído para que o treino do domínio mais avaliado tenha sido potenciado e, com isso, serem ocultados outros efeitos na cognição global. A primazia do domínio da memória enquanto foco de estimulação e, simultaneamente, medida de eficácia, desiderato tomado de forma consciente atendendo ao impacto dos défices de memória na DA e do objetivo principal do estudo, parece constituir-se como um constrangimento relativamente ao alcance que as intervenções neuropsicológicas poderão obter. Na literatura é referido que as intervenções serão tão mais eficazes quanto abarcarem um conjunto mais alargado de áreas treinadas (Bahar-Fuchs et al., 2013), pelo que o esforço de diversificar, por exemplo, a intervenção Memo+, com tarefas que visem o treino de funções diferentes, deverá ser futuramente aprimorado e alargado.

A utilização de um conjunto de instrumentos neuropsicológicos que visaram avaliar no seu todo a perceção de bem-estar dos participantes no estudo após as intervenções permitiu observar que, além do impacto significativo no funcionamento cognitivo, a intervenção SenseCam e a intervenção Memo+ tiveram um efeito imediato positivo em medidas não cognitivas, especificamente na sintomatologia depressiva e na perceção dada capacidade funcional. Este resultado corrobora, por um lado, aa relevância da utilização de intervenções desta natureza, dado o seu impacto imediato se alargar à perceção de maior bem-estar por estes pacientes (já referido por Clare, 2010 como sendo uma medida subjetiva de interesse para examinar a eficácia destas intervenções), mas, por outro lado, parece suscitar a questão sobre o que subjaz à presença destes efeitos não cognitivos, uma vez que os mesmos não acompanham, a longo prazo, os efeitos cognitivos. Numa primeira análise, poderá, também neste âmbito, estar a observar-se um constrangimento de medida, neste caso relacionado com a adequação dos instrumentos utilizados para avaliar os constructos pretendidos. A ausência de instrumentos de avaliação da sintomatologia depressiva, capacidade funcional e qualidade de vida especificamente elaborados para a população em estudo pode ter contribuído para a alcance diminuído na observação dos efeitos das intervenções nestas áreas de funcionamento. Por outro lado, estes resultados apenas imediatos poderão ir ao encontro do que é sugerido por alguns autores como sendo resultado da própria experiência de realização do treino (Barrack, 2012; Bredesen, 2014; Kelly, Loughrey, Lawlor, Robertson, Walsh, & Brennan, 2014), e não uma consequência indireta dos efeitos cognitivos (pois, caso fosse essa a justificação, esperar-se-ia que os efeitos fossem concomitantes). Um estudo com a SenseCam, em que os participantes apenas usaram a câmara sem visionar o seu conteúdo posteriormente, revelou efeitos cognitivos e não cognitivos apenas pela utilização do dispositivo (Sellen et al., 2010). Contudo, atendendo ao facto de que as intervenções do tipo Memo+, que envolvem treino intensivo com feedback sobre o desempenho nas tarefas, são frequentemente descritas na literatura como sendo menos motivadoras para os pacientes, dada a confrontação dos mesmos com as suas dificuldades cognitivos (Kapur, Glisky, & Wilson, 2004), seria esperado que esta intervenção tivesse um efeito nas medidas de bem-estar menos significativo do que na intervenção SenseCam, mesmo que apenas a nível imediato. Assim, uma outra hipótese para permitir compreender estes resultados poderá consistir no facto da perceção dos ganhos obtidos no treino cognitivo estar a contribuir para que estes pacientes manifestem uma perceção de bem-estar mais positiva do que antes da intervenção, e a ausência de feedback ao longo de seis meses contribuir para o desvanecimento desta perceção. Bahar-Fuchs e colaboradores (2013) e Oltra-Cucarella, Pérez-Elvira, Espert e McCormick (2016) referem o facto de os efeitos não cognitivos serem menos transferidos e estáveis do que os efeitos cognitivos). Para examinar esta hipótese em maior detalhe, seria importante considerar a avaliação após a intervenção em intervalos de tempo mais curtos (quinze dias, um mês, três meses), verificando qual a duração máxima do intervalo temporal em que os efeitos percebidos no bem-estar se mantêm. Outra hipótese seria manipular o tempo de duração da intervenção, no sentido de averiguar se uma intervenção mais longa produziria efeitos na perceção de bem-estar mantidos a longo prazo (Wilson, 2009).

De um modo geral, atendendo ao objetivo abrangente da presente investigação, pode concluir-se que a avaliação e constatação da eficácia de duas das três intervenções examinadas contribui, no sentido prático, para ponderar positivamente a relevância da sua utilização com pacientes com DA inicial, os quais revelaram conseguir beneficiar com a participação em sessões de estimulação cognitiva, benefício esse que pode estender-se a longo prazo.

SenseCam e o seu papel na DA

De forma específica, a presente investigação centrou-se no aprofundamento do conhecimento do potencial da câmara portátil SenseCam na fase inicial da DA, enquanto uma das ferramentas mais recentes referidas na literatura com potencial em termos da estimulação mnésica (e.g., Silva, Pinho, Macedo, & Moulin, 2016). A este respeito, os estudos englobados nesta dissertação permitiram obter dados exploratórios e corrobatórios relativamente a esta prótese de estimulação cognitiva e à sua importância como dispositivo de ajuda a pacientes com DA em fase inicial. Em primeiro lugar, embora o estudo piloto (Estudo 1 – *Parte 2, Secção 1*, Silva et al., 2013) tenha sido elaborado como uma espécie antecâmara do estudo clínico, para testar instrumentos de avaliação neuropsicológica enquanto medidas de eficácia, permitiu extrair informação até ao momento desconhecida sobre o impacto desta câmara. Apesar de ser sugerido em estudos anteriores o provável impacto da visualização das imagens da SenseCam no funcionamento cognitivo global, esse impacto não tinha ainda sido examinado de forma sistemática, mas somente avaliado quanto ao efeito desta visualização na posterior recordação da informação visionada (e.g., Berry et al., 2009; Browne et al., 2011; Hodges et al., 2006). Assim, a validação mais alargada do potencial da SenseCam para estimular a cognição foi encetada com o presente estudo. Para além disso, o facto de uma utilização significativamente curta (três dias) deste dispositivo ter revelado efeitos imediatos em instrumentos estandardizados de avaliação da memória e das funções executivas, para uma amostra de participantes idosos saudáveis, é indicador não somente do poder desta ferramenta para estimular a memória, mas da sua utilidade para população ainda sem défice de memória. Neste sentido, embora não tenha sido aprofundada esta ideia em outros estudos desta investigação, a SenseCam poderá assumir-se como um instrumento de intervenção cognitiva relevante na otimização do funcionamento cognitivo no envelhecimento saudável e, possivelmente, no adiamento da manifestação clínica de uma condição neurodegenerativa que possa vir a instalar-se. Esta hipótese encontra reforço na literatura (Valenzuela & Sachdev, 2009) que salienta que intervenções cognitivas eficazes são protetoras, no sentido da manutenção de um desempenho neuropsicológico ótimo no envelhecimento. Stern (2012) refere que este tipo de estimulação potencia a reserva cognitiva diminuindo o risco do desenvolvimento de um quadro neurodegenerativo. Apesar desta análise dos efeitos da SenseCam no envelhecimento normal não ter constituído, como se mencionou acima, um objetivo da presente investigação, o estudo realizado permitiu considerar áreas de aprofundamento futuras, em que o exame de uma utilização prolongada (à semelhança do que foi possível realizar no estudo clínico) deste dispositivo por idosos saudáveis ou em fase pré-clínica de demência se afigura relevante. A avaliação do impacto da SenseCam no desempenho cognitivo e no bem-estar de pacientes com DA em fase inicial foi, igualmente, um objetivo inovador da presente investigação, dado que os estudos realizados com este dispositivo na DA se centraram exclusivamente no impacto imediato da visualização das imagens obtidas com a esta câmara na recordação dos eventos desse modo registados (Crete-Nishiatha et al., 2012; Lee & Dey, 2008; Woodberry, Browne, Hodges, Watson, Kapur, & Woodberry, 2015). A comparação deste dispositivo com as intervenções Memo+ e Diário permitiu examinar em que medida a característica de se tratar de um dispositivo passivo em termos do treino requerido (Caprani et al., 2006) se revela uma mais valia relativamente a intervenções que exigem uma atuação intencional dos pacientes (obstáculo particular para os pacientes que negam as suas dificuldades; Lee & Dey, 2006). O facto do desempenho dos pacientes que utilizaram a SenseCam terem melhorado de forma semelhante relativamente aos pacientes que participaram no treino Memo+ sugere que, provavelmente, não será o carácter passivo e não exigente da SenseCam para os seus utilizadores que estará subjacente ao efeito desta intervenção, uma vez que uma intervenção ativa, exigente do ponto de vista dos recursos mobilizados para estes pacientes, forneceu ganhos similares. Contudo, na memória autobiográfica a intervenção SenseCam parece prover um efeito singular e com elevada magnitude, não obtido nas restantes intervenções (ver *Parte 2, Secção 2.1.*), ainda que na intervenção Memo+ sejam realizadas tarefas de treino especificamente elaboradas para estimular a memória autobiográfica (Serrano et al., 2004), e a compreensão deste efeito poderá contribuir para perceber a sua influência na cognição global. Quer estudos de neuroimagem, quer estudos que recorreram a questionários têm apoiado a teoria de serem as características das imagens captadas pela SenseCam que conduzem à estimulação de áreas do cérebro fulcrais no funcionamento mnésico, como o hipocampo e áreas do neocortex (Loveday & Conway, 2010; Milton, Muhlert, Butler, Smith, Benattayallah, & Zeman, 2011; St Jaques, Conway & Cabeza, 2011). O facto de as imagens captadas serem apontadas como mimética das características das memórias autobiográficas, nomeadamente devido à sua componente visual, de remeterem para a perspetiva do próprio indivíduo, e de serem recordações sumárias da realidade, faz com que estas imagens se assumam como pistas fortes para reforçar o traço mnésico e conduzir a um melhor desempenho (Conway, 2005). A partir desta consideração, fica integrado o efeito particular da SenseCam na memória autobiográfica e a generalização desse efeito para o funcionamento mnésico global. Deste modo, seria a qualidade da informação captada pela câmara e a estimulação cerebral que essa captação envolve que estaria na base do "efeito SenseCam" no funcionamento cognitivo e não o facto de se tratar de uma ferramenta passiva, como já fora descrito na *Parte 1. Secção 2* (Silva et al., 2016), com base na associação da teoria do apoio ambiental aos substratos neuronais. Apesar desta hipótese explicativa ser congruente com os resultados obtidos, a presente investigação não recolhe informação sobre as características e o conteúdo da informação obtida pela SenseCam para cada participante, de modo a compreender em que medida essas características influenciariam a magnitude do efeito da intervenção SenseCam entre os participantes desse grupo. A análise desta informação poderia oferecer uma confirmação mais robusta sobre a singularidade das imagens captadas pela SenseCam (tentando compreender o que torna as imagens SenseCam mais "memoráveis" relativamente a imagens captadas por uma máquina fotográfica tradicional; Isola, Xiao, Parikh, Torralba, & Oliva, 2014) como justificação sobre o seu efeito marcado no funcionamento cognitivo global em indivíduos com défices objetivos de memória.

Retomando o foco sobre o facto da intervenção SenseCam ser passiva e disso poder estar associado ao seu efeito positivo, quer no funcionamento cognitivo quer no bem-estar, embora os resultados obtidos e as hipóteses formuladas não apontem para que este seja o traço distintivo desta prótese mnésica, tal característica e a verificação de se obterem efeitos similares numa abordagem passiva e numa abordagem ativa levam a considerar as implicações que esta intervenção pode ter quando os pacientes se mostram resistentes à estimulação cognitiva, por negarem ou evitarem a confrontação com as suas dificuldade cognitivas (Choi & Twamley, 2013; Vogel, Stokholm, Gade, Andersen, Hejl, & Waldemar, 2004). Assim, ainda que os resultados obtidos não apontem a SenseCam como uma intervenção que tenha um efeito único no desempenho cognitivo (com exceção dos ganhos relativos à memória autobiográfica) nem a tornem uma opção significativamente mais vantajosa relativamente a programas de treino como o Memo+, em função das características dos pacientes, há lugar para a escolha de uma intervenção baseada em métodos passivos, na qual os ganhos se obtém mesmo quando os pacientes não se encontram motivados para o treino cognitivo (Lee & Dey, 2006). Tal afigura-se particularmente relevante se integrarmos a informação recolhida no Estudo 3 (*Parte 2, Secção 3*, Silva et al., submetido). A constatação da presença de anosognosia mnésica nos pacientes com DA inicial vem salientar que a consciência sobre o próprio funcionamento cognitivo (analisada relativamente ao funcionamento da memória, metamemória e conhecimento consciente dos seus défices de memória; Souchay, 2007) não aumenta com a participação em intervenções de estimulação cognitiva. Ainda que os participantes revelem consciência dos ganhos obtidos na intervenção a que foram sujeitos, tendo os participantes na intervenção SenseCam e Memo+ avaliado as sessões de forma mais positiva (através de um questionário de ganhos percebidos aplicados no final do treino a todos os participantes) do que os participantes da intervenção Diário, e apesar de alterarem os seus julgamentos de aprendizagem após o treino, não fazem de forma eficaz. Deste modo, a consciência da presença de ganhos após a intervenção não se transfere para a atualização das crenças que os pacientes desenvolvem sobre as suas capacidades cognitivas. Esta falha parece estar associada aos recursos cognitivos conscientes e controlados que esta atualização metacognitiva exige e que se encontra diminuída desde as fases iniciais desta doença. Este dado, que aprofunda e confirma os resultados descritos na literatura sobre a falta de "awareness" dos pacientes com DA acerca do seu desempenho cognitivo (Ansell & Bucks, 2006; Morris & Mograbi, 2013; Souchay, 2007) vem, assim, reforçar a pertinência de dispositivos como a SenseCam que, por não exigirem uma aprendizagem consciente de estratégias para estimular a memória, se torna tanto mais útil quanto menos capazes metacognitivamente estes pacientes forem. Para examinar esta última asserção seria relevante incluir a avaliação da consciência/insight cognitivo como elemento informativo sobre os pacientes, no sentido de compreender se esta variável poderá ser, por um lado, mediadora dos efeitos das intervenções cognitivas ou, por outro lado, mutável em função desses mesmos efeitos.

Além da implicação clínica da SenseCam como alternativa de intervenção de RN na DA junto de pacientes com baixo insight, o efeito destacado e singular da intervenção SenseCam na especificidade das memórias autobiográficas pode justificar a sua utilização em pacientes cujos défices cognitivos são circunscritos a este tipo de memória (lesões focais; Levine, 2004) ou em que a sua condição clínica se associa à deterioração do funcionamento autobiográfico (e.g., depressão de início tardio; Gonçalves, 2007). Deste modo, das implicações mais importantes do ponto de vista dos desenvolvimentos futuros das intervenções de RN com pacientes com DA identificamos este potencial da SenseCam poder corresponder a objetivos pessoais dos pacientes, podendo tornar estas intervenções mais adaptadas aos objetivos e necessidades individuais. Esta implicação entronca nas referências mais recentes relativamente a meta-análises de eficácia da reabilitação cognitiva na DA (Clare, Evans, Parkinson, Woods, & Linden, 2011; Olanzaran et al., 2010; Oltra-Cucarella et al., 2016) que apontam para que as intervenções sejam tão mais eficazes quanto mais se dirijam aos objetivos pessoais dos indivíduos alvo da reabilitação. Contudo, enveredar por este tipo de paradigma de definição de objetivos personalizados para a reabilitação (princípio postulado pela RN, *Parte 1, Secção 1,* Silva, no prelo) implica concomitantemente considerar diferentes indicadores de eficácia. Assim, é o momento de analisar de forma mais sistemática algumas linhas de investigação futuras que a presente pesquisa permite esboçar, no sentido de testar formas de aprimorar os ganhos das intervenções aqui examinadas, bem como testar indicadores de eficácia mais apropriados para as mesmas.

Linhas de investigação futuras

O carácter pioneiro desta investigação no que diz respeito à utilização prolongada dada câmara portátil SenseCam e da avaliação sistemática com recurso a instrumentos estandardizados da sua eficácia comporta algumas particularidades relativas aos estudos realizados. Sendo os dados obtidos importantes "primeiros passos", no sentido de aprofundar de forma progressiva o conhecimento do potencial deste dispositivo e a sua eficácia em comparação com outras intervenções de estimulação cognitiva na DA, o facto de se tratarem de "primeiros passos" confere a perspetiva de que muitos "passos" estejam ainda por dar. Embora já tenha sido referido, ao longo desta discussão integrativa, algumas sugestões de aprofundamento futuros, sintetizamos aqui as linhas de investigação que nos parecem mais relevantes, algumas das quais formulamos tendo em consideração as limitações que identificamos na presente investigação.

Esta investigação iniciou o escrutínio relativo à eficácia das intervenções de estimulação cognitiva baseadas na câmara SenseCam tendo por base instrumentos de avaliação neuropsicológica. Muito embora essa opção metodológica tenha considerado o facto deste tipo de avaliação ser a medida de eficácia mais válida e sistemática no campo da RN, a mesma também comporta limitações, nomeadamente o facto de ser pouco ecológica do ponto de vista do funcionamento dos indivíduos no seu quotidiano. Tal limitação foi observada no presente estudo, não só porque algumas medidas parecem ter falhado em avaliar o constructo em causa nesta população clínica (Estudo 2b) como, noutros casos, as medidas para avaliar o constructo em questão foram insuficientes (e.g., instrumentos de avaliação do funcionamento executivo, Estudo 2a). Deste modo, e tomando em consideração aquilo que é considerado nos princípios mais recentes da RN na DA (Hampstead, Gillis, & Stringer, 2014), seria relevante desenvolver estudos futuros para testar a eficácia destas intervenções nas quais fossem utilizados cumulativamente diferentes tipos de medidas de eficácia (e.g., questionários de autorresposta, avaliação de informadores e medidas ecológicas), de forma a obter uma perceção mais abrangente e clara sobre os efeitos das intervenções testadas. Um tipo de medida de eficácia, cada vez mais referido como opção preferencial para examinar a utilidade das intervenções de RN, é o delineamento de objetivos específicos (*goal-planning*), em que o acordo da sua concretização após intervenção com o paciente e/ou informadores é referido como tendo mais utilidade na estruturação e avaliação dessas intervenções (Clare, 2010; Wilson, 2003). Neste âmbito, estas medidas múltiplas deveriam ser integradas num desenho do tipo estudo controlo aleatório que, embora difícil do ponto de vista das intervenções de RN, permitiria controlar um conjunto significativo de variáveis do avaliador a que no presente estudo não se procedeu.

A presente investigação abre, igualmente, caminho para o potencial da SenseCam e do Memo+ enquanto intervenções que poderão contribuir para adiar a manifestação da uma condição neurodegenerativas (e.g., DA), dados os resultados promissores obtidos com população saudável e na fase inicial da DA. Assim, havendo manifestamente uma lacuna no que diz respeito à progressão do défice cognitivo, seria positivo avaliar num estudo longitudinal indivíduos com um quadro pré-clínico de deterioração cognitiva (como o Declínio Cognitivo Ligeiro) no sentido de compreender, mediado pelas várias intervenções, a conversão ou não destes casos para demência, partindo da consideração de que as intervenções cognitivas podem prevenir ou adiar a progressão clinica (Buschert et al., 2012).

Tratando-se de uma investigação que colheu informação baseada em medidas estandardizadas sobre os efeitos isolados da atuação destas intervenções na DA em fase inicial, seria interessante considerar os potenciais efeitos cumulativos das duas intervenções que se revelaram eficazes para a cognição e bem-estar imediato. Assim, seria estimulante desenvolver um programa de sessões de treino cognitivo que contemplasse os exercícios inseridos na intervenção Memo+, mas que a eles acrescessem sessões de visionamento de imagens captadas pelos pacientes com a SenseCam, ao longo do período de intervenção. Tendo em consideração que a magnitude do efeito obtido variou de moderada a forte para a maioria das medidas utilizadas na presente investigação, seria expectável que essa magnitude aumentasse com a utilização simultânea das duas ferramentas de estimulação cognitiva. Nesta análise, seria de reforçar a importância de introduzir um grupo de controlo que fosse mais comparável com as intervenções a testar, provavelmente recorrendo a imagens captadas por câmaras fotográficas tradicionais (Bourgeois, Dijkstra, Burgio, & Allen-Burge, 2001). Tal grupo de controlo permitiria não só controlar a presença de informação visual em todas as intervenções implementadas, mas igualmente refletir sobre o substrato do efeito da SenseCam se encontrar relacionado com o tipo de imagens, significativamente diferentes das que são captadas por câmaras tradicionais (Woodberry et al., 2015).

A abordagem seguida no Estudo 3, que consistiu em utilizar o contexto das intervenções cognitivas para compreender o funcionamento da metacognição dos pacientes com DA em fase inicial, retomou a hipótese já referida na literatura (Choi & Twamley, 2013; Clare, 2010) de que atividades de estimulação cognitiva podem contribuir para aumentar as capacidades metacognitivas, i.e., o conhecimento sobre as próprias capacidades cognitivas. Essa estimulação da consciência sobre o funcionamento cognitivo é entendida como sendo fundamental para aumentar a motivação dos pacientes com demência para a estimulação cognitiva e, com isso, diminuir desistências e promover o comprometimento ativo dos participantes nas atividades desenvolvidas. Como tal, e sendo que no presente estudo o nível motivacional, embora numa das intervenções tenha sido estimulado (Memo+), não foi avaliado nem antes nem após a intervenção, seria interessante examinar essa variável em relação com a metacognição. Na presente investigação apenas foi analisada a metacognição através dos julgamentos de aprendizagem, o que sendo uma abordagem consistente com a literatura sobre o tema, fornece apenas uma visão parcial sobre o funcionamento metacognitivo dos sujeitos. Assim, paralelamente ao exame da motivação dos participantes dever-se-iam incluir mais métodos de avaliação da metacognição (Souchay, 2007). Através desta avaliação mais aprofundada poderíamos aceder a maior entendimento sobre o contributo que os métodos de estimulação cognitiva aqui experimentados de forma pioneira na DA têm nestas variáveis e, caso tal não se verificasse, ponderar que alterações se poderiam introduzir nestas intervenções para que se tornem mais promotoras de "awareness", tanto quanto esta fase de DA ainda o permita (Cosentino, 2014).

Apesar das limitações que a presente investigação apresenta, mencionadas ao longo desta discussão, radicadas, no nosso entender, nos constrangimentos do número amostral, nos métodos de avaliação da eficácia das intervenções e na natureza transversal e não duplamente cega da investigação (que obrigam a precaução nas interpretações e generalização dos resultados obtidos), as descobertas proporcionadas pelos vários estudos surgem como um contributo válido e inovador do ponto de vista das respostas que a psicologia pode dar nas intervenções não farmacológicas para pacientes com DA em fase inicial. Em primeiro lugar, é a primeira vez que o benefício de uma camara portátil é examinado com medidas estandardizadas e em comparação com outras intervenções cognitivas de relevo, numa amostra que, embora reduzida, é homogénea quanto às variáveis sociodemográficas, funcionamento cognitivo global e estadiamento clínico, condição raramente encontrada nas investigações de estimulação cognitiva na DA (Bahar-Fuchs et al., 2013). Em segundo lugar, a manutenção dos efeitos a longo prazo das duas intervenções experimentais testadas (SenseCam e Memo+) por comparação com uma condição de controlo ativa (entendida como um método mais adequado do que o método lista de espera, por razões éticas e pela relação que o contacto com o investigador ao longo de um período de tempo largo pode ter na magnitude dos efeitos encontrados; Kinser & Robins, 2013) reforça a premência de disseminar intervenções de estimulação cognitiva nas boas práticas com pacientes com DA imediatamente após o diagnóstico, no sentido de reduzir o impacto da doença, limitando a disfuncionalidade e auxiliando o funcionamento quotidiano destes pacientes e dos seus cuidadores.

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"E, nunca saciado,

Vai colhendo ilusões sucessivas no pomar.

Sempre a sonhar e vendo

O logro da aventura.

És homem, não te esqueças!

Só é tua a loucura

Onde, com lucidez, te reconheças…"

(Miguel Torga)

ANEXOS

Anexo 1 – Sessões do programa Memo+

Sessões Programa Memo+

(11 SESSÕES, 1 HORA/SESSÃO)

Sessão 1

Entrevista motivacional inicial
Psicoeducação sobre problemas de memória no envelhecimento
Apresentação do programa de treino

Sessão 2

Exercícios:
Atenção por favor1 (15 min)
Contar um conto (20 min)
Ações do dia-a-dia (20 min)
Feedback

Sessão 3

Exercícios:
Atenção por favor2 (15 min)
Contar um conto (20 min)
Quem é quem (20 min)
Feedback.

Sessão 4

Exercícios:
Quem é quem (20 min)
Palavra puxa palavra (10 min?)
Não se esqueça de… (20 min)
Feedback.

Sessão 5

Exercícios:
Palavra puxa palavra (10 min)
Faces famosas (20 min.)
Ainda se lembra? (20 min.)
Feedback.

Sessão 6

Exercícios:
Faces famosas (20 min.)
Palavra puxa palavra (10 min.)
Ainda se lembra? (20 min.)
Feedback.

Sessão 7

Exercícios:
Palavra puxa palavra (10 min.)
Faces famosas (20 min.)
Não se esqueça de (20 min.)
Feedback.

Sessão 8

Exercícios:
Lista de compras (40 min)
Ações do dia – a – dia (20 minutos)
Feedback.

Sessão 9

Exercícios:
Faces famosas (20 minutos)
Lista de compras (40 min.)
Feedback.

Sessão 10

Exercícios:
Lista de compras (25 min)
Quem e quem? (20 minutos)
Ainda se lembra? (20 minutos)
Feedback.

Sessão 11

Exercícios:
Ações do dia-a-dia (20 min.)
Ainda se lembra? (20 min.)
Questionário de ganhos percebidos

Anexo 2 – Descrição das tarefas do Programa Memo+

Tabela a. Descrição das tarefas e indicadores de eficácia do programa MEMO+

Área cognitiva	***Descrição da tarefa***	***Estratégias cognitivas***	***Duração***	***Referências***
Atenção				
Atenção seletiva e sustentada	***Atenção, por favor!!*** Esta tarefa é composta por dois exercícios (atenção 1; atenção 2). Num dos exercícios é solicitado ao participante que encontre os algarismos "1" e "2", sendo que deverá encontrar o algarismo "1" nas linhas pares e o algarismo "2" nas linhas ímpares. O número de algarismos por linha aumenta ao longo dos ensaios de treino. O segundo exercício consiste numa tarefa de cancelamento e é composto por três etapas em que o participante deverá marcar o estimulo igual ao estimulo-alvo. Na primeira etapa, é apresentada uma figura geométrica que deverá ser identificada entre um conjunto de seis figures (circunferência, quadrado, cruz, triângulo, estrela e traço). Na etapa seguinte o nível de dificuldade aumenta uma vez que o estímulo-alvo é composto por duas figures, que apenas poderão ser identificadas se se encontrarem na mesma posição. Na terceira e última etapa é treinada a capacidade do participante para mudar o foco da atenção. O número dos tipos de estimulo alvo, o número de linhas e o número de figuras é o mesmo das etapas anteriores, sendo a única diferença a de que o estímulo-alvo muda em cada linha de figuras. Indicadores de eficácia: acertos; omissões; falsos alarmes (indicadores por minuto)		15 minutos por sessão 3 sessões	**Adaptado de:** Sohlberg, M., McLaughlin, K, Pavese, A., Heidrich, A., & Posner, M. (2000) Evaluation of attention process training and brain injury education in persons with acquired brain injury. *Journal of Clinical and Experimental Neuropsychology*, *22* (5), 656-676.

Tabela a. (continuação)

Área cognitiva	*Descrição da tarefa*	*Estratégias cognitivas*	*Duração*	*Referências*
Memória de trabalho				
Memória de trabalho verbal	***Contar um conto*** De modo a testar e treinar a função do ciclo fonológico (um dos sistemas 'escravos' de sistema executivo central) foi elaborada uma tarefa de escuta e recitação de um conto. É lido ao participante um pequeno conto em quatro partes, lidas na ordem incorreta. É pedido então ao participante que repita o conto parcial imediatamente após ouvir cada trecho. Após escutar todas as partes do conto, é pedido ao participante para evocar o conto completo de forma organizada e com lógica. São apresentados quatro contos com níveis crescentes de dificuldade (cada parte do conto tem apenas	Repetição, Trabalho com o material de teste (os participantes têm de reorganizar a informação para	20 minutos por sessão 2 Sessões	**Adaptado de:** Netto, T. (2010) [Working memory training in older adults] *PhD Thesis.* University of São Paulo.
Memória a longo prazo				
Memória Declarativa				
Memória episódica visual	***Quem é quem?*** São apresentadas nove fotografias de faces para o participante aprender; as fotografias são inseridas num plano quadriculado (29 * 29 cm) com um traçado que representa uma matriz 3 por 3 assemelhando-se a um tabuleiro de jogo. Cada fotografia é apresentada individualmente e é colocada sequencialmente no tabuleiro após ser apresentada. O experimentador diz o nome da pessoa mostrada na imagem e pede ao participante que crie uma mnemónica visual para esse nome, por exemplo: "a Maria dos cabelos encaracolados". Em seguida, o experimentador coloca a fotografia no tabuleiro. Após visualizar todas as fotos e criar mnemónicas visuais para cada uma, é pedido ao participante que selecione uma imagem de acordo com uma pista dada pelo experimentador. São realizados alguns ensaios e em cada um deles a posição da fotografia no tabuleiro muda. Estes ensaios de treino seguem o paradigma da recuperação espaçada, de modo a que, após o primeiro intervalo de 10 segundos ser bem-sucedido, o intervalo seguinte será de 20 segundos, 40 segundos e 60 segundos, consecutivos a êxito na evocação. Quando ocorrer um erro na evocação, é dado feedback imediato e tem lugar um novo ensaio cujo intervalo de tempo é igual ao do ultimo ensaio bem-sucedido. Indicadores de eficácia: último intervalo de tempo com evocação correta; número de ensaios necessários para a evocação correta do máximo de imagens, respostas corretas; erros de evocação.	Elaboração semântica e recuperação espaçada	15 minutos (tempo aproximado dependendo dos sucessos na evocação) 3 sessões	**Adaptado de:** Cherry, K., Walvoord, A., & Hawley, K. (2010) Spaced retrieval enhances memory for a name-face-occupation association in older adults with probable Alzheimer's disease. *The Journal of Genetic Psychology, 171*, 168-181.

Tabela a. (continuação)

Área cognitiva	*Descrição da tarefa*	*Estratégias cognitivas*	*Duração*	*Referências*
Memória a longo prazo				
Memória Declarativa				
Memória episódica visual (cont.)	***Faces famosas*** Neste exercício, é apresentado como estímulo uma série de fotografias a preto e branco. Serão incluídas fotografias de pessoas famosas, retiradas do Teste de Faces Famosas (Martins, Loureiro, Rodrigues, & Dias, 2005), imagens de jornais e revistas. Serão no total 24 fotografias, divididas em 4 conjuntos de itens, cada conjunto incluindo 3 imagens de pessoas famosas facilmente nomeáveis e três imagens de pessoas famosas dificilmente nomeáveis. Após cada conjunto de seis itens, é utilizada a técnica de eliminação ou desvanecimento de pistas. Cada imagem é apresentada, inicialmente com o nome completo visível, sendo que em cada apresentação subsequente é eliminada uma letra do nome, da direita para a esquerda, até que apenas a primeira letra do nome seja apresentada. É pedido ao participante que evoque o nome completo da pessoa famosa apresentada na imagem, mas sem tentar adivinhar. Se o participante não responde, por não ter a certeza da resposta, é acrescentada uma letra do nome até a resposta ser correta, e o exercício prossegue com o mesmo paradigma de eliminação. Dado este exercício ser apresentado ao longo de várias sessões, na sessão seguinte os nomes alvo serão apresentados com menos uma letra do que o último ensaio bem-sucedido ocorrido na sessão anterior. Indicadores de eficácia em cada sessão: número de ensaios necessários para recordar o nome complete das pessoas famosas; É testada a evocação em seguida com dois procedimentos: *Evocação livre* - é apresentada uma imagem ao participante e pedido para indicar o nome desta, sem qualquer pista fornecida. *Evocação guiada* - é apresentada uma imagem ao participante e dada a seguinte indicação: ‘O nome desta pessoa começa por “Amá...”, pode dizer-me o seu nome completo?’	Eliminação ou desvanecimento de pistas	15 minutos por sessão 4 sessões	**Adaptado de:** *Winter, J., & Hunkin, N. (1999)* Dunn, J., & Clare, L. (2007) Learning face-name associations in early-stage dementia: Comparing the effects of errorless learning and effortful processing. *Neuropsychological Rehabilitation, 17,* 735 – 754.

Tabela (continuação)

Área cognitiva	*Descrição da tarefa*	*Estratégias cognitivas*	*Duração*	*Referências*
Memória a longo prazo				
Memória Declarativa				
Memória episódica verbal	***Lista de compras*** É lida uma lista de compras com produtos pertencentes a diferentes categorias semânticas. É pedido ao participante, após escutar cada item da lista, que refira a categoria semântica a que pertence esse item; por exemplo, se um item for “maçãs” é pedido ao participante que diga “maçãs são frutos”. Após categorizar todos os itens, é-lhe pedido que evoque todos os itens da lista que se lembra (teste de evocação imediata). Se o participante evoca corretamente todos os itens da lista de compras, o intervalo entre ensaios aumenta sucessivamente (1.5 min, 3 min, 6 min, 12 e 24 minutos). Após uma falha cometida na evocação, o experimentador ajuda o participante referindo as categorias que foram definidas na fase de aprendizagem: “Lembra-se quais produtos da lista eram frutos?” Se o participante acertar, o intervalo de tempo para o ensaio seguinte aumenta, caso o participante erre, o intervalo entre ensaios decresce para o ultimo intervalo cuja evocação foi correta. Cada lista inclui entre 5 a 7 palavras, com imaginabilidade elevada e representação visual fácil. As palavras não se repetem entre sessões. Se o participante evoca corretamente a lista complete no intervalo de 24 minutos, o número de palavras aumenta na sessão seguinte. Nos intervalos deste exercício o participante deverá envolver-se em atividades cujos recursos mnésicos não sejam claramente ativados. Indicadores de eficácia: ultimo ensaio bem-sucedido; número de itens da lista	Categorização Recuperação espaçada	30 minutos por sessão 3 sessões	**Adaptado de:** Lee, S., Park, C., Jeong, J., Choe, J., Hwang, Y.. Park, C., et al. (2009) Effects of spaced retrieval training on cognitive function in Alzheimer’s disease (AD) patients. *Archives of Gerontology and Geriatrics*, *49*, 289-293.
Memória semântica	***Palavra puxa Palavra*** Nesta tarefa de fluência são ditas categorias gerais de palavras ao participante, sendo solicitado que este diga palavras pertencentes às categorias mencionadas, tantas quantas se lembre. Na primeira sessão são usadas diversas categorias, todas diferentes. Na segunda sessão é usada uma categoria nova e uma categoria que tenha sido usada na primeira sessão. Considera-se que a apresentação repetida da mesma categoria tem como propósito a criação de diversas listas da mesma categoria – que confere evidência da aprendizagem implícita e da ativação semântica promovida por este exercício. Indicadores de eficácia: número de palavras geradas em cada categoria; número de repetições; número de transferências entre sessões.	Geração livre Método indireto	10 Minutos por sessão 4 Sessões	**Adaptado de:** Arkin, S. (2001) Alzheimer rehabilitation by students: Interventions and outcomes. *Neuropsychological Rehabilitation*, *11*, 273 – 317

Tabela a. (continuação)

Área cognitiva	*Descrição da tarefa*	*Estratégias cognitivas*	*Duração*	*Referências*
Memória a longo prazo				
Memória Declarativa				
Memória Prospetiva	***Não se esqueça de...*** Tarefa experimental de memória prospetiva: é usada uma versão adaptada de *The Text-Reading Task* (Ellis, Kvavilashvili, & Milne, 1999), teste este que inclui o paradigma de tarefa dual, de modo a determinar a capacidade do participante para realizar uma tarefa de memória prospetiva ao mesmo tempo que está envolvido numa tarefa corrente. Os participantes leem em voz alta uma pequena história de 2 páginas (tarefa corrente) na qual se encontra uma palavra-alvo (pista de recordação prospetiva) apresentada diversas vezes, aparecendo pelo menos duas vezes por página. É pedido aos participantes que substituam a palavra alvo por outra palavra (instrução de recordação prospetiva). No final do procedimento experimental, os participantes são questionados acerca da sua memória das instruções, dadas na tarefa experimental. Imediatamente após a repetição das instruções, é pedido aos participantes que respondam à seguinte questão: "O que precisa de fazer durante a leitura do texto?" A questão é, então, repetida em intervalos sucessivamente mais longos de 5 segundos, 10 segundos, 20 segundos e 40 segundos, até um máximo de 3 minutos. Sempre que o participante responder "Não sei", as instruções deverão ser repetidas e o intervalo de tempo até ao questionamento seguinte deverá ser o mesmo do último ensaio em que o participante recordou corretamente as instruções. Indicadores de eficácia: acertos substituição; acertos na recordação das instruções; intervalo de tempo com recordação correta das instruções.	Codificação elaborada Recuperação espaçada	20 minutos por sessão 2 sessões	**Adaptado de :** Fish, J., Wilson, B., & Manly, T. (2010). The assessment and rehabilitation of prospective memory problems in people with neurological disorders. A review. *Neuropsychological Rehabilitation*, *20*, 161-178.
Memória autobiográfica	***Ainda se lembra?*** Este exercício envolve o treino baseado no paradigma de Revisão de Vida. O treino da memória autobiográfica, através de acontecimentos positivos específicos, envolve uma técnica de evocação guiada. Procede-se a uma entrevista estruturada por estádios de desenvolvimento abrangendo todos os períodos da vida de um indivíduo, nomeadamente a infância, família e lar, adolescência, idade adulta. Para cada etapa de desenvolvimento no qual o treino autobiográfico é dividido, existem 14 questões, formuladas de modo a ativar memórias específicas. Indicadores de eficácia: número de memórias evocadas para cada período de vida; especificidade das memórias evocadas.	Reminiscência – evocação guiada	20 minutos por sessão 4 sessões	**Adaptado de:** Serrano et al. (2004) Life Review Therapy using autobiographical retrieval practice for older adults with depressive symptomatology. *Psychology and Aging*, 19, 272-277.

Tabela a. (continuação)

Área cognitiva	*Descrição da tarefa*	*Estratégias cognitivas*	*Duração*	*Referências*
Memória não declarativa				
Memória Procedimental	***Ações do dia-a-dia*** Neste exercício são treinadas atividades de vida diária instrumentais, solicitando ao participante que realize uma tarefa daquelas em que tenha obtido uma pontuação superior de incapacidade funcional (medida de avaliação funcional: IAFAI). Os participantes são apoiados através das técnicas de desvanecimento e modelação, de forma a serem bem-sucedidos na tarefa. São também dadas indicações ao participante para que este registe, numa folha de papel, passos simples para realização da tarefa sem erros. Indicadores de eficácia: duração da realização da tarefa (intervalo entre a instrução verbal dada pelo experimentador e a conclusão da tarefa pelo participante); número de ensaios necessários para a conclusão bem-sucedida da tarefa	Desvanecimento, Feedback imediato, Modelação	20 minutos por sessão 3 sessões	**Adaptado de:** Zanetti, O., Zanieri, G., Giovanni, G. D., Vreese, L. P. D., Pezzini, A., Metitieri, T., & Trabucchi,M. (2001). Effectiveness of procedural memory stimulation in mild Alzheimer's disease patients: A controlled study. *Neuropsychological Rehabilitation*, *11*, 263–272

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