RELEARNING OF ACTIVITIES OF DAILY LIVING: A COMPARISON OF THE EFFECTIVENESS OF THREE LEARNING METHODS IN PATIENTS WITH DEMENTIA OF THE ALZHEIMER TYPE

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Abstract: This study examined the effectiveness of three different learning methods: trial and error learning (TE), errorless learning (EL) and learning by modeling with spaced retrieval (MR) on the relearning process of IADL in mild-to-moderately severe Alzheimer's Dementia (AD) patients (n=52), using a 6-weeks randomized controlled trial design. The participants had to relearn three IADLs. Repeated-measure analyses during pre-intervention, post-intervention and 1-month delayed sessions were performed. All three learning methods were found to have similar efficiency. However, the intervention produced greater improvements in the actual performance of the IADL tasks than on their explicit knowledge. This study confirms that the relearning of IADL is possible with AD patients through individualized interventions, and that the improvements can be maintained even after the intervention.

Key words: Alzheimer's dementia, learning procedure, IADL.

Introduction

Alzheimer Dementia (AD) is a form of progressive cognitive deterioration that alters memory and learning to such a degree that it heavily interferes with daily living. Functional autonomy loss is a key feature of AD, as it follows a slow degradation process in cognitive functions and in the ability to perform instrumental activities of daily living (IADL), such as managing finance, food preparation or using a dish washer (1-3). Even mild degrees of cognitive deterioration may have negative effects on the ability to perform complex IADL (4). So far, there is no cure for dementia available, nor disease modifying drugs. However, non-pharmacological interventions targeting at learning or relearning potentially useful IADL may contribute to improve quality of life and well-being in AD patients, as it may increase their functional autonomy.

Generally, the learning process follows an unstructured manner, known as the Trial and Error (TE) method: skill acquisition occurs by guessing the correct response and learning from any errors made. However, some teaching methods have been found to facilitate the learning of material in amnesic patients (5-7).

The Errorless Learning (EL) method is described as a teaching technique using feed forward instruction whereby people are prevented, as far as possible from making mistakes during learning (8, 9). In AD patients, such errors reduction may be achieved by a variety of means, such as providing adapted cues prior performing the target task, and limiting the patient's guessing (10, 11).

In the Modeling with spaced Retrieval (MR) approach, the patient is asked to remember the task sequence and reproduce it after a delay (12, 13). Similar approaches to MR have been used and found reliable for the teaching of new skills such as movement sequences or skills in both the general and Alzheimer's populations (14, 15).

These learning procedures may help the encoding and the retrieval of recently learned material. Most evidences of the benefits of EL or MR in people with memory impairments comes from studies which investigated learning of word lists, verbal paired-associates, names, names of pictured objects, and general knowledge items (12, 16-20). However, there is evidence that reducing errors during learning (EL), or modeling the action to be performed (MR) allow even moderate and severe AD patients to (re)learn procedural tasks (5-7).

As the disease progresses, there is consistent evidence that explicit or declarative memory function, which is related to conscious knowledge acquisition and intentional recollection of previous experiences, is worsened in AD patients (21). Through behavioral enrichment training, the residual explicit memory of AD patients may play an important role during the (re)learning process (22, 23). Accordingly, as their explicit memory capacities are decreasing, AD patients are believed to heavily rely on implicit memory function, which refers to the learning capacity of complex information without awareness or intention. Overall, there is substantial evidence to support that the severity of the explicit memory impairment due to AD may favored learning procedures that relied more on implicit learning capacities (22, 23). Mild AD patients are, thus, thought to have better performance in implicit learning of new motor skills instead of explicit learning (24).

As AD is characterized by a significant alteration in the performance of IADL (1), these techniques could be employed to develop effective interventions to relearn IADL in AD patients. Learning methods could be implemented in ecological

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tasks of everyday life, such as domestic activities, and therefore improve the autonomy of AD patients. Further, behavioral enrichment training targeting the relearning of daily living tasks is highly relevant for both patients and caregivers, as it will ease the disease burden, enhance cognitive functioning and slow down the loss of autonomy (5; 25-31). Recent studies aiming at improving IADL in AD patients show interesting results (5, 32, 33), but no randomized study has compared yet the different learning methods with each other.

The piloting phase of this study (34) tested three learning methods (TE, EL and MR) in the acquisition of IADL in 14 AD patients within 6 sessions. The data showed that moderate to moderately severe AD patients relearned IADL tasks, with a consistent improvement of the physical performance that remain stable at one week follow-up. In this pilot study, EL and MR procedures resulted in a significantly better learning, compared to the TE procedure. Moreover, the improvement for the implicit performance (physical performance) was higher than for the evaluation of explicit knowledge, suggesting that implicit learning capacities are less impaired than explicit ones in AD patients. However, in this pilot study, only 6 training sessions were used, over a 1-week period. Moreover, all participants received all training conditions. For each patient, a learning procedure was thus only evaluated for one task.

In this line, the goal of the present randomized prospective clinical trial was to evaluate the effectiveness of three methods of individual interventions; namely the Trial and Error learning, Errorless Learning and Modeling with spaced Retrieval on the relearning process of IADL in mild-to-moderately severe AD patients, using a 6-weeks randomized controlled trial design.

Methods

Participants

74 patients were initially recruited by the Nice research Memory Center. They were either living in a nursing home (n=53), at their personal home (n=16), or in an extended care facility center (n=5). Participants had to meet the following inclusion criteria: (1) Diagnosis of mild to moderately severe AD, with a MMSE score between 10 and 26; (2) Fulfill the DSM-IV-TR and NINCDS-ADRDA criteria for Alzheimer's dementia type (35, 36) ; (3) Aged 60 and older; (4) Not able to complete without cues the proposed tasks during the screening interview. Subjects were not included in case of (1) severe deficits in alertness; (2) schizophrenia or depressive disorders according to the DSM IV criteria (3) NPI frequency x severity score higher than 6 in one of the domains belonging to the NPI Hyperactivity factor (37): Agitation, euphoria, disinhibition, irritability, aberrant motor behavior; (3) known medications that could interfere with the intervention, such as antipsychotic medication (except AD medication). Informed consents were obtained in accordance with the declaration of Helsinki. Ethical approval was received from an Individuals Protection Committee.

Study Design

The intervention was standardized during the piloting phase (34).

Patients were randomly assigned to one of the three intervention methods (TE, EL, or MR). They were trained in individual sessions twice a week during 6 weeks on three IADL, one IADL task at a time. Each session lasted 2 hours. All participants received the same amount of sessions, the same amount of practice for each task. All participants were re-assessed one week (post-intervention evaluation) and 4 weeks (delayed evaluation) after the completion of the last training session. Trained therapists administered the different learning methods and post-evaluations.

The trained IADL tasks were chosen by the recruiter, based on previously acquired autonomy assessment and together with the patient, from a set of 50 activities. The chosen tasks had to be of interest for the patient, who was not able to perform them without cues. Possible activities included for example "Using the oven", "Preparing a tea" or "Set the alarm clock". The complete list of activities is available at the following address: http://www.innovation-alzheimer.fr/homepage in the Project section.

Materials

Each step of the task has a cue card containing a written description, and a cue card with a picture representing how to carry out the step (see Figure 1 for example). The instructions have been ecologically validated with patients during a piloting phase (34).

Figure 1
Visual cues of the steps in the IADL task "prepare a coffee"

Intervention procedure

Participants were randomized in three independent groups. Each group received one of the three interventions, consisting of different learning method:

- Errorless Learning (EL): Errorless learning refers to the use of feed forward instruction (i.e., how to do) before actions to prevent learners from making mistakes. The therapist presents the different steps with the following instruction and visual cues e.g., "Here are steps that you need to do to make some coffee, please repeat them". The therapist gives cues before the completion of each step, e.g., for coffee machine: "You can take the water tank and fill it with water". At each step the patient receives verbal and visual cues (pictures and written cues). Then, the cue cards are hidden, and the therapist asks immediately to give the answer about the steps involved. The therapist allows the participant to try finding the solution (less than 5 seconds), if the answer or action is not immediately given, the participant receives a cue, and moves on to the next step. During cueing the patient will mostly receive verbal and visual cues (pictures and written instructions) and if necessary physical help.
- Modeling with spaced Retrieval (MR): Modeling with Spaced Retrieval techniques consist of performing the steps of the task in front of the patient, who has to recall these steps after a certain delay. The therapist gives the same tailored baseline information for each task as follow for the coffee machine: "Here is a coffee machine, I will show you how to use it and you will do it after me". The therapist issues specific information for each step as follow: "I will show you how to do a "specific action" then you will do it after me".

Using tailored mastery modeling, the therapist shows the steps in front of the patient, with a special emphasis on adjusting the modeling just above the patients' abilities. The therapist used verbal cues during the realization of the steps. To ensure the completion of the task within the 30 minutes training, and based on the result of pilot studies, a time interval of 30 seconds is used. Before the recall, the therapist has to undo each of the previous steps that involve a modification of the material (e.g., empty the water tank). During the interval the therapist had to provide informal talking with the patient that is not directly related to the nature of the material used during the session. After an interval of 30 seconds, the therapist asks: "Can you repeat the activity I showed you since the beginning of the session".

The participant had to recall the different steps of the activity and how to do them. After a successful interval of 30 seconds, the therapist adds one or more steps to the sequence, and remodels the whole new sequence. If during rehearsal a mistake is produced, the therapist gives the correct answer by remodeling and returns to the repetition of the whole sequence. When the mistake happens in the middle of a previously learned sequence (e.g., the patient is at step 8 and there is a mistake at step 6), the therapist gives a cue (remodeling) for the mistaken step and asks to continue. If the patient was unable to continue, the therapist shows the correct step (remodeling) and returns to the previously learned interval during which the retrieval was successful and repeats the sequence again.

- Trial and Error (TE): Trial and Error refers to the regular unstructured learning. Here the patient is encouraged to complete the task by himself. When a mistake occurs, the therapist will correct it immediately. Verbal cues are only provided if the patient is unable to find and complete the correct next step or commits mistakes. The therapist uses general instructions such as: "Here is "task", I will ask you to "actions"", followed by specific instruction, "and I will help you after you have tried".

Each session consisted of the evaluation followed by the training of three IADLs, one at a time.

For each IADL, three types of evaluation were performed:

- Implicit Knowledge evaluation (IK): the participant is asked to actually perform the task (physical performance)
- Explicit Knowledge evaluation with visual cues (EKv): the participant is asked to sort pictures of the different steps in the right order
- Explicit knowledge evaluation with written cues (EKw): the participant is asked to sort the written instruction of the different steps in the right order

Scoring procedure

The primary outcome of the intervention was the performance of the participants.

The assessment of each step of the task was made by the therapist, using three categories concerning the performance of the participant: competent; low confidence in his own ability during the decision making process, action planning failure; or absence of answer. All categories are clinically relevant in performance analyses to assess the behavioral and rehabilitation efficacy of each intervention.

1) Competent: The step is successfully performed.

2) Questionable/Ineffective:

• Questionable steps are indicated by the patient's hesitation and doubt about how to perform a step. This category involves planning problems. A step was scored as 'Questionable' if the patient expressed verbal hesitation, asked "is it right…" (even after a correct step), or if the patient showed motor hesitation such as touching the object and quickly retrieving the hand, making small or non-purposeful movements, touching the object but not finishing the motor activity.

• Depending on the nature of the task, some steps could be ineffective. For example: pulling out the top drawer of a dish washer (before the lower one) and then putting the right element inside it, is not an ineffective step. On the other hand; pulling out the top drawer of a dish washer (before the lower one) and then trying to put the pan, or knives or other elements that are normally fitting in the lower drawer are both ineffective steps. Ineffective steps include: the repetition of a step that has already been done; actions which are not related to the task; or the use of the material for another action.

3) Deficit: This term designates an absence of answer or reaction.

The same procedure was used to assess and score physical performance (IK) and explicit knowledge of the task (with written and visual cues, EKw and EKv).

Each task step was assessed following a 3-point scale (ranging from 3=competent to 1=deficit), so that the assessment procedure provided an overall score for each task sequence. In order to make each task comparable, the total score was adjusted on a 100-points scale, with 100% indicating perfect performance.

The secondary outcome concerned participants' cognitive and behavioral status.

The cognitive status was evaluated using the Mini-Mental State Examination (MMSE) (38), which provides an overall assessment of global cognitive functioning (e.g. memory, language, attention). The MMSE score ranges from 0 to 30, with higher score indicating better cognitive functioning.

Behavioral disturbances were evaluated using the French version of the Neuropsychiatric Inventory (NPI) (39, 40). The NPI consists of a 15-20 minutes interview at the family caregiver usually caring for the patient. The NPI score range from 0 to 144, with higher score indicating higher behavioral disturbances.

The MMSE and the NPI were administered during the screening evaluation, and at the post-intervention and the 1-month delayed evaluations.

Blinding

The recruiters who screened the patients played no role in the intervention during the study. The assigner was an independent researcher in charge of the randomization with no other task during this trial and no contact to the therapists or the patients during the trial. Medical staff and therapists were kept blind to study design, outcomes and group assignment.

For post-intervention and follow-up assessments, the therapists assessed participants' performances with whom they had no contact during the trial. Only the study statisticians and the data monitor had access to the un-blinded data, but none had any contact with the study participants.

Statistical analysis

Descriptive statistics (mean and standard deviation) were calculated for participant's socio-demographics characteristics and cognitive and behavioral scores at baseline. Kruskal-Wallis tests and Fisher's Exact tests were performed in order to test for statistical difference between groups for these variables at baseline.

Performances and cognitive and behavioral scores according to the Learning Group (EL, MR or TE), to the type of Evaluation (IK, EKv, or EKw), and to the Session (pre-intervention, post-intervention or delayed evaluation) were analysed using ANOVA analyses of variance. Post-hoc analyses were performed using Tukey HSD tests. Correlation analyses were performed between cognitive scores and performances.

The significance level was set at α=.05.

Results

Participants' characteristics

Of the 74 patients initially recruited, 22 dropped out of the study: 17 patients withdrew or refused to complete the trial, 3 patients had health issues making them unable to complete the trial, 1 patient developed behavioral disturbances, 1 patient showed motor impairments, and 1 patient died. Since insufficient data was available for these participants, they were excluded from the analyses. 52 patients thus performed all the training sessions.

Patients were divided into three groups in the following order: 15 patients in the EL group, 16 patients in the MR group, and 21 patients in the TE group.

Table 1 illustrates patients' socio-demographics and cognitive and behavioral evaluation scores at baseline. There was no significant difference between groups on socio-demographics, MMSE and NPI scores, and the proportion of patients with diagnosis of apathy.

The number of steps in the IADL tasks trained by the participants varied from 3 to 14 (mean = 7.26; SD = 2.3). The average number of steps in the EL group (mean = 7.27; SD

Table 1

Participants' socio-demographics, MMSE score, and NPI total score at baseline

	EL n=15	MR n=16	TE n=21	Total n=52	p-value
Age (mean and SD in years)	83.67 (7.28)	86.81 (8.19)	83.86 (7.21)	84.71 (7.67)	0.33 [a]
Gender (% female)	73.33%	68.75%	66.67%	69.23%	0.93 [b]
MMSE (mean and SD)	15.93 (3)	17.94 (4.19)	18.1 (3.62)	17.42 (3.77)	0.22 [a]
NPI total score (mean and SD)	8.92 (5.33)	15.19 (15.93)	16.9 (14.76)	14.22 (13.79)	0.29 [a]

Abbreviations: EL = Errorless Learning; MR = Modeling with spaced Retrieval; TE = Trial and Error learning; a. Kruskal-Wallis Test; b. Fisher's Exact Test

Table 2
Means and Standard Deviations of participants' performances in the pre-intervention, the post-intervention and the 1-month delayed evaluations, depending on their group (EL, MR, or TE) and the type of evaluation (IK, EKv, EKw)

	Pre-intervention evaluation			Post-intervention evaluation			Delayed evaluation		
	IK	EKv	EKw	IK	EKv	EKw	IK	EKv	EKw
EL	20.78 (14.64)	38.42 (25.64)	51.56 (27.06)	62.38 (27.1)	57.31 (28.93)	71.98 (22.17)	47.42 (23.05)	48.64 (26.64)	61.76 (26.51)
MR	19.71 (15.17)	36.92 (24.09)	46.15 (25.94)	56.33 (27.97)	50.58 (25.46)	62.75 (30.1)	55.42 (29.46)	57.04 (20.76)	65.69 (21.27)
TE	23.04 (15.21)	38.52 (20.97)	50.03 (29.83)	64.02 (24.38)	65.41 (22.86)	77.94 (17.65)	56.98 (19.13)	65.06 (15.81)	74.44 (11.67)

Abbreviations: EL = Errorless Learning; MR = Modeling with spaced Retrieval; TE = Trial and Error learning; IK = Implicit Knowledge; EKv = Explicit Knowledge with visual cues; EKw = Explicit Knowledge with written cues.

= 2.51), the MR group (mean = 7.63; SD = 2.36) and the TE group (mean = 6.98; SD = 2.04) was not significantly different (Kruskal-Wallis test: H(2,52) = 0.82, p=0.66).

IADL tasks scores

Table 2 presents the results of participants' performances during the pre-intervention evaluation, the post-intervention evaluation, and the 1-month delayed evaluation, according to their group and to the type of evaluation.

Results showed a significant effect of the session (F(2, 94)=56.86, p<.001), indicating an improvement in participants' performances. A significant difference of performances was also observed between all types of evaluation (F(2, 94)=21.99, p<.001). No significant effect was found between the groups (F(2, 47)=.77, p=.47). The interaction between the group and the session was not significant (F(4, 94)=1.61, p=.18). However, there was a significant interaction between the session and the type of evaluation (F(4, 188)=9.25, p<.001).

Thus, in order to make the results clearer, separate analyses were performed for the learning phase performances and for the differed performances.

Learning phase

Results showed that overall participants' performance improved significantly across all groups as well as across all learning sessions (F(1, 49)=97.64, p<.001). The average performance score was 36.21% (SD = 25.5) in the pre-intervention evaluation, and was 63.75% (SD = 26.31) in the post-intervention evaluation. There was no significant difference between the groups during the learning phase (F(2, 49)=.93, p=.4), indicating no difference between average performance scores in EL, MR and TE groups (respectively 50.4% (SD = 29.85), 45.41% (SD = 28.87), and 53.16% (SD = 28.87)). Moreover, the interaction between the sessions and the group was not significant, indicating similar evolution of performances across learning sessions for the three groups (F(2, 49)=1.11, p=.34) (see Figure 2).

However, there was a significant difference in the participants' performance depending on the type of evaluation (F(2, 98)=20.94, p<.001). Post-hoc analysis revealed that EKw scores (mean score 60.41%, SD = 28.44) were significantly higher than both EKv scores (mean score 48.26%, SD = 26.9, p<.001) and IK scores (mean score 41.27%, SD = 29.36, p<.001). The difference between EKv and IK scores was just above significance threshold (p=.051).

The interaction between the type of evaluation and the group was not significant, indicating that the difference in performance depending on the type of evaluation was consistent across groups (F(4, 98)=.12, p=.97). However, the interaction between the type of evaluation and the session was statistically significant (F(2, 98)=15.57, p<.001). Complementary post-hoc analysis revealed that the evolution of IK scores between pre-intervention and post-intervention evaluations (mean evolution score 39.82%, SD = 24.76) was significantly higher than the evolution of EKv scores (mean evolution score 20.51%, SD = 22.02, p<.001) and the evolution of EKw scores (mean evolution score 22.67%, SD = 28.1, p<.001) (see Figure 3).

Differed performances

Results showed no difference in overall performances between 1-month delayed evaluation and post-intervention evaluation (F(1, 49)=2.92, p=.09), indicating that participants' performances remained stable 1 month after the end of the intervention.

No difference was observed between groups (F(2, 49)=1.43, p=.25). However, as in the learning phase, results showed a significant difference between the type of evaluation (F(2, 98)=10.61, p<.001). EKw scores (mean score 69.82%, SD = 23.7) were thus significantly higher than EKv scores (mean score 58.19%, SD = 25.86, p<.001) and IK scores (mean score 57.46%, SD = 25.78, p<.001) (see Figure 3).

No interaction could be found between the group and the type of evaluation (F(4, 98)=.43, p=.79), nor between the type of evaluation and the session (F(2, 49)=2.43, p=.09). Moreover, the interaction between the group and the session also indicated a non-significant trend (F(2, 49)=2.72, p=.07). Complementary post-hoc analyses showed that the evolution of the scores in the EL group (mean evolution score -11.3%, SD = 20.92) almost significantly differed from the evolution of scores in the MR group (mean evolution score 2.83%, SD = 25.87, p=.06), while it did not significantly differed from the evolution of scores in the TE group (mean evolution score -3.63%, SD =15.39, p=.38) (see Figure 2).

Figure 2
Mean performance at the pre-intervention, post-intervention, and delayed session, for the 3 learning conditions, all types of evaluation together

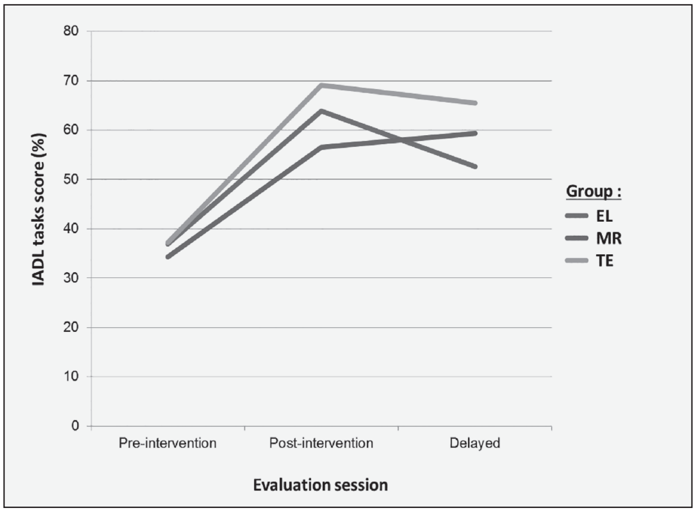
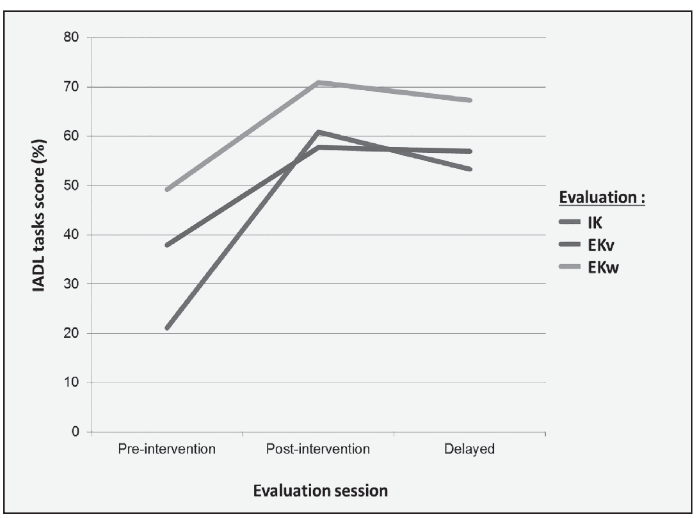


Figure 3
Mean performance at the pre-intervention, post-intervention, and delayed session, for the 3 types of evaluation, all learning groups together



Cognitive and behavioral scores

No effect of the group could be found on the MMSE score (F(2, 49)=1.89, p=0.16), nor on the NPI score (F(2, 49)=.24, p=.78). Similarly, no effect of the session could be found on the MMSE score (F(2, 98)=1.5, p=.23) nor on the NPI score (F(2, 98)=.46, p=.63). There was no significant interaction effect between the session and the group on the MMSE score (F(4, 98)=1.24, p=.3), nor on the NPI score (F(4, 98)=1.41, p=.23).

Furthermore, complementary analyses revealed a significant correlation between MMSE scores at baseline and the evolution of IK performances in the learning phase for the EL group (r=.6, p=.02), indicating that a higher MMSE score resulted in a greater learning of the IADL tasks. Other correlation between MMSE and other types of evaluation and for MR and TE groups were all non-significant.

Discussion

This study demonstrated that mild-to-moderately severe AD patients could successfully relearn IADL tasks using a number of different learning methods. Indeed, all patients in this study improved their performances after the intervention, regardless of the technique used for the learning. Thus, Errorless learning and Modeling with spaced retrieval were shown to be as effective as Trials-and-errors learning, because participants of each group improved their performances similarly. Moreover, the improvements in participants' performances remained stable at least 1 month after the end of the intervention, although performances in the Errorless learning group slightly decreased. These results confirmed that it is possible to obtain a consistent improvement in the performance of IADL tasks which remains stable until 1 month after the training was completed (33, 34).

Our results also showed that explicit knowledge evaluations produced better performances than implicit knowledge evaluation. However, this effect was not depending on the severity of patients' cognitive impairment, as no association could be found between MMSE scores and the type of evaluation. An explanation could be that in implicit knowledge evaluations, participants had to generate all the steps of the task by themselves, whereas in explicit knowledge evaluations, cues of the steps were presented to them. Thus, explicit knowledge evaluations may have been less effortfull than implicit knowledge evaluations, resulting in better performances. However, we observed that participants made greater performance improvements in the implicit knowledge evaluation in comparison to the explicit knowledge evaluations, as previously observed (34, 41). This may be in favor of our hypothesis that implicit learning capacities are better preserved than explicit memory in AD patients. In addition, the greater mental effort involved in the self-generation of the steps of the task, requires more explicit attention, which might have been of importance in the greater performance improvements of the implicit evaluations (42, 43). As already reported in previous studies, the intervention did not improve cognition (33), and moreover did not provoke behavioral disturbances in the patients.

To our knowledge, this is the first controlled study showing that several IADLs can be relearned simultaneously by patients with AD. This is a promising result, given that the administration of the intervention was short and simple, and well-received by the patients. In this study, 3 learning methods were employed, 2 of them utilizing errorless principles as a basis for interaction with the patients. The results revealed that in our study, similar improvements were obtained after each learning methods. Jones and colleagues (44) already mentioned that in certain circumstances, traditional trial-and-error learning methods might be more efficient that errorless techniques.

In particular, our results showed that patients with higher MMSE score had greater improvements in physically performing the IADLs for the EL group, whereas no association could be found between MMSE score and other learning groups. These results suggest that the efficiency in learning a new instrumental task with a TE or a MR method does not depend on the participants' cognitive level, while this is the case with the EL method. This could be caused by the fact that in the EL group, participants had to understand and memorize the cues which were presented to them before performing the required steps. Thus, the cognitive load may have been more important in this group, resulting in better learning in less-impaired patients. Conversely, in the MR and the TE groups, patients are more active in the learning, which is more interactive, and might have been more attractive, with less needs of conceptualization. Thus, improvements in performances did not rely on the cognitive level, as measured by the MMSE score. This hypothesis could account for the slight decrease of performance in the EL group 1 month after the end of the intervention, the learning being less stable.

Clare and Jones (10) mentioned that in some conditions, the efficiency of learning may rely more on the effort needed for the task than in the reduction of errors during its realization, which is supported by our study. In our case, the three methods were effective for the relearning of IADLs, but the methods for which participants were more active (MR and TE) produced the more stable performances.

This study has several limitations. The relatively small sample size could have prevented significant results to be found. However, the improvement of performances in the relearning of IADLs in AD patients and the relations between learning methods, cognitive level and effort, are promising results, as they show that a number of methods exist for AD patients to gain more autonomy, and that these methods can be adapted to patients characteristics and interests.

In this trial, each participant received a different set of tasks. However, the calculation of a percentage score made us able to directly compare the performance on the tasks of different complexity, and to provide tasks which were individually tailored to the participants' needs.

While it is difficult to conclude if the relearning effect was completely due to the methods or to the presence and attention of the therapist, it is also possible that some patients practiced by themselves, without the therapist, between experimental sessions. This could have resulted in the learning of correct as well as incorrect performances of some steps, which may have been a confounding factor. However, learning curves were coherent for each patient, suggesting that they did not differ in terms of actual task performance.

Despite these limitations, the present study demonstrates that mild-to-moderately severe AD patients can simultaneously relearn several IADLs with EL, MR or TE methods, and that the improvements can be maintained at least 1 month after the end of the learning. These methods may involve cognition, effort and interactive learning at different levels, and thus can lead to individualized interventions to promote autonomy in AD patients. Further studies should focus on the degree of implication and interaction of the patients with the therapist, in order to develop optimal interventions.

Conflict of Interest Disclosures: The author(s) declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

Ethical standards: The study and the medical procedures presented in this paper are consistent with French national recommendations. This study obtained approval from the Ethical Research Comittee «Sud Méditerranée V» in February 2010.

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