How should we teach everyday skills in dementia? A controlled study comparing implicit and explicit training methods

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Abstract

Objective: To compare the immediate and delayed effects of implicit and explicit training methods for everyday skills in patients with dementia.

Design: Counterbalanced self-controlled cases series.

Subjects: Convenience sample of 10 patients with dementia (Mini-Mental State Examination score between 15 and 26) and 16 age- and education-matched controls.

Intervention: Two everyday tasks (using a microwave oven and a coffee machine) that were novel to all participants were trained in five 15-minute sessions. Each participant learned both tasks, one using an implicit learning method (modelling) and the other using an explicit learning method (providing verbal cues). Tasks and conditions were counterbalanced.

Measures: The participants’ performance was videotaped to assess how well the tasks were performed before training, after each training session, and 7–10 days after the final training session. A rater, who was blind to the training method used, scored the number of correctly executed steps by viewing the videotapes.

Results: The two training methods were effective in both the patient and healthy control groups, with there being a significant baseline-to-follow-up increase in the number of correctly completed steps (\(P < 0.001\)). There were no differences between the training methods (\(P = 0.16\)) and no significant interaction between training method and group (\(P = 0.31\)).

Conclusions: Older patients with mild dementia are able to acquire new skills that are relevant for daily life, showing a similar rate of learning regardless of whether implicit or explicit learning techniques are used.

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Introduction

The aim of rehabilitation is to help people with impairments due to injury or illness to achieve their optimum level of physical, psychological, social and vocational well-being. Several approaches are used to enable people to stay in their most appropriate environment, such as cognitive rehabilitation to ameliorate cognitive deficits. Nowadays, increased interest in the management of the consequences of dementia, to maintain a high quality of life, has resulted in the application of rehabilitation approaches in dementia to help optimize patients’ overall functioning. Moreover, the rapid increase in the ageing population and in the number of people with dementia has far-reaching consequences for our national health systems and is a major cost driver in health care. Helping older people to stay independent as long as possible is an important way to contain these costs.

Because cognitive dysfunction is central to dementia, cognitive rehabilitation is important in these individuals. Guiding principles, such as errorless learning, enhance learning by facilitating residual episodic memory functioning. Another effective technique is the activation of preserved procedural, implicit, memory. Implicit learning refers to the acquisition of new skills and habits without conscious awareness. Because implicit memory function remains relatively intact in Alzheimer’s dementia, interventions using implicit learning methods, such as motor learning and perceptual priming (implicit memory), may promote lasting improvements in the performance of everyday functions. A third approach includes the use of external compensatory strategies to optimize functioning, such as calendars or notebooks.

In this study, we investigated the acquisition of everyday functions relevant for people with dementia, such as learning to use a microwave oven or making a cup of coffee. These everyday functions comprise motor action sequences, and in our review on this topic we concluded that patients with Alzheimer’s dementia are able to implicitly learn/relearn motor action sequences to a sufficient level, provided that learning conditions are adjusted to their needs and abilities. Experimental studies have shown that there is a substantial difference between implicit (which is intact) and explicit (which is impaired) learning in Alzheimer’s dementia. The question, however, is whether the results obtained with laboratory tasks can be extrapolated to everyday tasks.

Although only a few studies have evaluated the acquisition of novel, everyday functions in Alzheimer’s dementia, results are promising and show that procedural memory training of activities of daily living is effective in this patient group. This was confirmed more recently by Graff and colleagues, who demonstrated that occupational therapy improved the daily functioning of patients with Alzheimer’s dementia despite their limited learning abilities. In that study, patients were taught to optimize their compensatory and environmental strategies to improve their performance of daily activities.
Although these results are encouraging, none of these functional studies distinguished between implicit and explicit learning strategies, which is important since the loss of explicit learning ability is a prominent feature in Alzheimer’s dementia.\textsuperscript{17} The terms implicit and procedural are often incorrectly used interchangeably. The traditional view of procedural learning\textsuperscript{18} is that individuals successively complete three stages in the acquisition of motor skills: the cognitive stage, the associative stage and finally the autonomous stage. According to this view, procedural learning always starts with explicit learning. In contrast, Willingham and Goedert-Eschmann\textsuperscript{19} more recently posited that implicit and explicit learning may show a parallel course during procedural learning: both implicit and explicit training approaches in isolation lead to both implicit and explicit knowledge (memory). This implies that procedural learning arises from both explicit and implicit training. Laboratory studies have shown that procedural learning relies on implicit learning procedures and implicit knowledge in patients with Alzheimer’s dementia. In this study, we investigated whether this is also the case for everyday functions.

In the present study, we compared an implicit and an explicit method to train healthy older people and patients with dementia to perform everyday tasks. We expected that the implicit method would be more effective in the patients with dementia, because explicit memory is reduced in dementia and procedural learning effects are observed after implicit training in laboratory tasks, and that both training methods would be effective in the healthy older adults.

**Method**

**Participants and neuropsychological screening**

A convenience sample of 12 older patients with mild to moderate dementia was recruited from a group-treatment facility in a local residential care home. All attended the facility at least two days a week because of their cognitive problems and the need for additional care that could not be provided at home. All had been diagnosed with dementia by a general practitioner, geriatrician or a mental health worker, in accordance with the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR) criteria.\textsuperscript{20} The aetiology was unknown in most patients. Exclusion criteria were a history of psychiatric or neurological diseases (e.g. stroke), and hearing and sight problems that interfered with the training. A group of 16 healthy, age-matched controls was recruited via the patients (i.e. spouses or other family members were asked to participate). None had a history of neurological or psychiatric disease (self-report). After receiving both oral and written information about the procedure, all participants gave their written informed consent prior to their participation, in accordance with the declaration of Helsinki. Informed consent was also obtained from a relative of the patients with dementia.

Before the training sessions, the participants were screened with the Mini-Mental State Examination (MMSE\textsuperscript{21}) to assess overall cognitive functioning and estimate the severity of dementia. In the healthy control group, all participants scored above 25, and in the dementia group 5 participants scored between 20 and 25 (mild dementia) and 5 scored between 10 and 20 (moderate dementia).\textsuperscript{22} The 8-Word Test from the Amsterdam Dementia Screening battery (ADS-6)\textsuperscript{23} was used to measure explicit verbal memory. This latter test consists of five trials in which eight unrelated words are presented verbally; after each presentation the participants are asked to recall as many words as possible. After a 15-minute delay they are asked to do so again, followed by a 16-word recognition trial (with the eight presented words in random order intermixed with new distracter words).
Tasks and training

We selected two, approximately equally demanding, everyday functions: preparing a cup of coffee using a Philips Senseo coffee machine and heating up a cup of water in a microwave oven (convection microwave oven, HE). None of the participants had used the devices before.

All participants (both healthy controls and patients with dementia) were trained individually. They were alternately assigned to one of four possible training/task/order combination: implicit Senseo followed by explicit microwave; explicit Senseo and implicit microwave; implicit microwave and explicit Senseo; explicit microwave and implicit Senseo. The participants learned to perform each activity during five, 15-minute sessions, during which each task was trained five times. These five sessions were separated by an interval of at least 3 hours, and took place on 2 or 3 days. Baseline assessment was performed directly before the first training session; the follow-up measurement was done 7–10 days after the fifth training session. The baseline and five training sessions of the second task were started at least 3 hours after the last training session for the first task. Participants trained one task explicitly and the other implicitly. See Figure 1 for a flow diagram of our study.

Task performance was assessed at baseline, after each training session, and at follow-up. If a participant made a mistake in any of the constituent components of the task during the tests, he or she was corrected by the trainer, who then demonstrated the next step in order to avoid cumulative effects of errors. All these tests were videotaped by the trainer and scored at a later date by an independent rater who was blind to the training method used and order of training. The rater was not blind to the hypothesis. Although the rater did not know which participants had been diagnosed with dementia, it cannot be ruled out that the conduct of the participants betrayed the presence of dementia in some participants. As an additional check the trainer, who was not blind to the condition, also rated the videos. Comparing the ratings by the trainer and the blind rater resulted in a high interrater reliability (Spearman correlations: median: 0.96, range: 0.80–1.00). We used only the data of the blind trainer in further analysis.

Each task was subdivided into 10 steps or actions, which are described in Tables 1 and 2. When trained explicitly, the participants received verbal instructions only. They were asked to learn the steps by heart. In the implicit training sessions, the participants copied the movements of the trainer, immediately and action by action, without receiving written or verbal instructions. During the implicit training sessions, the participants were prevented from making any errors (errorless learning), while in the explicit training sessions errors were allowed, but corrected instantly.

Data analysis

The rater scored the number of correctly executed steps by viewing the videotapes. First, repeated-measure general linear model (GLM) multivariate tests were conducted with session (6 levels: baseline and five learning trials) and training method (2 levels: implicit vs. explicit) as within-subject factors and group (patients vs. controls) as between-subjects factor. The difference between the number of successful actions after the last training session (T5) and at follow-up was used as the main measure of retention. Effect sizes were calculated for each effect ($\eta^2_p$) to indicate the proportion of variance of the dependent variable that was uniquely explained by the specific factor or interaction. Effect sizes were considered to be clinically significant if $\eta^2_p > 0.1$ (i.e. ‘moderate’ to ‘large’ effects in Cohen’s nomenclature).

Repeated-measures multivariate tests (GLM) were conducted with sessions as within-subject factor and type of task...
(microwave versus Senseo) as between-subject factor, to evaluate task differences. Also, repeated-measures multivariate tests (GLM) were conducted with sessions as within-subject factor and order of training (explicit training first vs. implicit training first) as between-subject factor to control for training-order effects. Correlations were computed between cognitive test scores (MMSE and 8-Word Test) on the one hand and the main test outcomes (i.e. correctly performed steps following the final session (T5) and follow-up, and the performance differences between baseline and T5, baseline and follow-up, and follow-up and T5 (retention)), on the other.

**Results**

One patient refused to cooperate after a few training sessions, and a second patient was excluded after initial testing, since no impairments on the MMSE and the 8-Word Test were found in this patient, possibly because of his or her high premorbid intellectual functioning. Thus, the patient group consisted of 10 participants. Table 3 lists the participants’
demographic details and cognitive screening scores. Education was scored using 7 categories, 1 being the lowest (less than primary school) and 7 the highest (academic degree). The patient and healthy control groups were comparable with respect to age, education, and sex.

Figure 2 shows the mean number of correctly performed actions per session for both groups. A significant within-subject effect was shown for session \((F(5,20) = 42.78, P < 0.001, \eta_p^2 = 0.91)\), but not for training method (implicit vs. explicit training) \((F(1,24) = 2.09, P = 0.16, \eta_p^2 = 0.08)\). A significant interaction was shown between session and group (patients vs healthy controls) \((F(5,20) = 5.36, P = 0.003, \eta_p^2 = 0.57)\), but not between training method and group \((F(1,24) = 1.07, P = 0.31, \eta_p^2 = 0.04)\). The interaction between session and training method was marginally significant \((F(5,20) = 2.17, P = 0.10, \eta_p^2 = 0.35)\). The interaction between session, training method, and group was significant \((F(5,20) = 2.68, P = 0.052, \eta_p^2 = 0.40)\).

Overall, the patient group performed worse than the control group during training (explicit: \(F(1,24) = 30.33, P < 0.001, \eta_p^2 = 0.53\); implicit: \(F(1,24) = 54.02, P < 0.001, \eta_p^2 = 0.69\)). There was no significant interaction between session and group for the explicit condition \((F(5,20) = 1.60, P = 0.21, \eta_p^2 = 0.29)\), but there was for the implicit condition. The patient group learned slower, as reflected by the significant interaction between session and group \((F(5,20) = 3.22, P = 0.03, \eta_p^2 = 0.45)\).

With regard to retention (T5–follow-up), a significant within-subject effect was shown for session \((F(1,24) = 8.87, P = 0.007, \eta_p^2 = 0.22)\) and for training method \((F(1,24) = 4.70, P = 0.04, \eta_p^2 = 0.16)\). No significant interaction effects were found for training method, session, or group.

### Table 1. Actions and verbal instructions for the two training methods for the microwave task

<table>
<thead>
<tr>
<th>Action</th>
<th>Explicit training method</th>
<th>Implicit training method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Fill the cup with water</td>
<td>Fill the cup with water</td>
<td>Trainer says: ‘Please, repeat my actions, step by step’, then fills the cup with water</td>
</tr>
<tr>
<td>2) Open the microwave door</td>
<td>Open the microwave door by pulling the handle</td>
<td>Opens the door by pulling the handle</td>
</tr>
<tr>
<td>3) Take the aluminium rack out</td>
<td>Take the aluminium rack out</td>
<td>Takes the aluminium rack out</td>
</tr>
<tr>
<td>4) Place the cup inside the microwave</td>
<td>Place the full cup inside the microwave</td>
<td>Puts the cup inside the microwave</td>
</tr>
<tr>
<td>5) Close the door</td>
<td>Close the door by pushing it</td>
<td>Closes the door</td>
</tr>
<tr>
<td>6) Push the ‘Watt’ button</td>
<td>Push the top button</td>
<td>Pushes the button at the top</td>
</tr>
<tr>
<td>7) Push it again</td>
<td>Push the button again so that 75 appears on the display</td>
<td>Pushes the button again</td>
</tr>
<tr>
<td>8) Set the timer</td>
<td>Turn the time button to the left until the display indicates 10 seconds</td>
<td>Turns the time button to the left until 10 seconds is displayed</td>
</tr>
<tr>
<td>9) Push the start button</td>
<td>Push the start button</td>
<td>Pushes the start button</td>
</tr>
<tr>
<td>10) Open the microwave door after the ready signal</td>
<td>When the stop signal sounds, open the door by pulling the handle</td>
<td>Opens the door by pulling the door after the stop signal has been sounded</td>
</tr>
</tbody>
</table>

*The participants were given verbal instructions and were asked to learn the actions by heart. Errors were corrected during performance and verbal instructions were provided if needed.

bThe trainer asked the participant to copy the actions she demonstrated without any further verbal instructions.
was shown between session and group ($F(1,24) = 0.30, P = 0.59, \eta^2_p = 0.01$) or between training method and group ($F(1,24) = 0.62, P = 0.44, \eta^2_p = 0.02$). There was a significant interaction between session and training method ($F(1,24) = 8.60, P = 0.007, \eta^2_p = 0.26$). The interaction between session, training method and group was not significant ($F(1,24) = 0.67, P = 0.42, \eta^2_p = 0.03$). In the explicit condition, performance did not decrease significantly ($F(1,24) = 0.03, P = 0.87, \eta^2_p = 0.001$) and there was no group interaction ($F(1,24) = 0.03, P = 0.87, \eta^2_p = 0.001$). However, in the implicit condition, performance decreased in both groups ($F(1,24) = 16.42, P < 0.001, \eta^2_p = 0.41$), but there was no significant interaction between group and sessions ($F(1,24) = 0.87, P = 0.36, \eta^2_p = 0.04$).

Analyses showed that there was a significant within-subject effect for task in both groups ($F(1,24) = 9.12, P = 0.006, \eta^2_p = 0.28$), indicating that the microwave task was slightly more difficult than the Senseo coffee machine task. The interaction between task and group was not significant ($F(1,24) = 0.23 P = 0.63, \eta^2_p = 0.01$). Task order did not influence the results; there was no significant

### Table 2. Actions and instructions for the two training methods for the Senseo coffee machine task

<table>
<thead>
<tr>
<th>Action</th>
<th>Explicit training method$^a$</th>
<th>Implicit training method$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Lift the water tank from the back of the coffee machine</td>
<td>Lift the plastic container from the back of the coffee machine by pushing its top backwards</td>
<td>Trainer: 'Simply repeat my actions, step by step,' then takes the plastic tank from behind the coffee machine</td>
</tr>
<tr>
<td>2) Fill it with water (at least up to the minimum level indicated)</td>
<td>Fill it with water up to the minimum level</td>
<td>Fills it with water up to the minimum mark</td>
</tr>
<tr>
<td>3) Place it back in its holder</td>
<td>Place the water tank back in the machine, bottom first</td>
<td>Places the water tank back</td>
</tr>
<tr>
<td>4) Push the ‘On’ button</td>
<td>Push the middle button to heat the water</td>
<td>Pushes the middle button</td>
</tr>
<tr>
<td>5) Open the lid of the machine</td>
<td>Open the lid of the machine by pulling the black handle upwards</td>
<td>Opens the lid</td>
</tr>
<tr>
<td>6) Take a coffee pad</td>
<td>Take a coffee pad</td>
<td>Takes a coffee pad</td>
</tr>
<tr>
<td>7) Place it into the coffee-pad holder in the machine as instructed</td>
<td>Place it in the coffee-pad holder with the flat side of the pad facing up</td>
<td>Places it in the coffee-pad holder with the flat side facing up</td>
</tr>
<tr>
<td>8) Close the lid</td>
<td>Close the lid by pushing the black handle forward and down</td>
<td>Closes the lid</td>
</tr>
<tr>
<td>9) Place a cup in the middle of the tray</td>
<td>Place a cup in the middle of the tray</td>
<td>Places a cup in the middle of the tray</td>
</tr>
<tr>
<td>10) Push the left button (one cup) when the start button stops flickering</td>
<td>Push the left button (one cup) when the start button stops flickering, signalling the water has been heated</td>
<td>Pushes the left button for one cup when the start button stops flickering</td>
</tr>
</tbody>
</table>

$^a$The participants were given verbal instructions and were asked to learn the actions by heart. Errors were corrected during performance and verbal instructions were provided if needed.

$^b$The trainer asked the participant to copy the actions she demonstrated without any further verbal instructions.
interaction between sessions and order of training in either task (Senseo: $F(5,20) = 0.49$, $P = 0.78$. $\eta^2_p = 0.11$; microwave: $F(5,20) = 0.92$, $P = 0.49$, $\eta^2_p = 0.19$).

Correlations were computed for the dementia group only, because almost all controls had obtained maximum scores at the end of the training and at follow-up. No significant correlations were found between the cognitive test scores (MMSE, 8-Word test total, 8-Words test recall and 8-Words test retention) and the main training outcomes.

**Table 3.** Demographics and cognitive screening scores for the two groups

<table>
<thead>
<tr>
<th></th>
<th>Control group (n = 16)</th>
<th>Dementia group (n = 10)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>Age</td>
<td>76.3</td>
<td>7.1</td>
<td>67–90</td>
</tr>
<tr>
<td>Educational level</td>
<td>5</td>
<td>1.6</td>
<td>3–6</td>
</tr>
<tr>
<td>MMSE</td>
<td>27.7</td>
<td>1.7</td>
<td>25–30</td>
</tr>
<tr>
<td>8-Word test total score</td>
<td>28.5</td>
<td>6.7</td>
<td>14–39</td>
</tr>
<tr>
<td>8-Word test recall</td>
<td>5.3</td>
<td>1.5</td>
<td>1–8</td>
</tr>
<tr>
<td>8-Word test recognition</td>
<td>7.8</td>
<td>0.4</td>
<td>7–8</td>
</tr>
</tbody>
</table>

MMSE, Mini-Mental State Examination.

**Figure 2.** Mean number of correctly completed actions per group and per training method for each session. BL, baseline assessment; T1–T5, tests for the five training sessions; FU, follow-up test; AD, Alzheimer’s disease patient group; CON, control group.
(number of correctly performed steps at T5, follow-up and the performance difference between baseline and T5, baseline and follow-up, and follow-up and T5).

**Discussion**

In this study, older patients with mild to moderate dementia and healthy, age-matched controls learned two household tasks for the first time, one through implicit training (i.e. modelling) and the other through explicit training (by giving verbal cues). Our hypothesis that implicit training would be more effective in the patients with dementia was not confirmed: both training methods were effective in both groups. In addition, both groups showed a small, yet significant decrease in performance during the 7- to 10-day follow-up after implicit, but not explicit, training. On the basis of our results, we conclude that elderly patients with mild dementia and moderate memory problems are able to learn new skills irrespective of the type of training.

Although the patients’ performance improved after the five training sessions, it was still worse than the performance of the control participants. However, it is possible that their performance would have improved further if more training sessions had been used. For example, a study in which patients with Alzheimer’s dementia were trained to use a mobile phone\(^27\) showed that the patients had only mastered 50–80% of the skill after five training sessions, whereas they had implicitly learned the skill after three months of training. Our study showed that six of the ten patients were able to execute nine or all ten steps correctly after the fifth and final coffee machine training session. In the microwave test, four had reached that level, with four patients having mastered eight steps. However, we feel our results are promising, especially since training programmes including a high number of training sessions are often not feasible in clinical practice.

Although we used a rater who was blind to the training method used and diagnosis of dementia, violation of blinding cannot be ruled out completely. The participants’ behaviour, as recorded on the videotape, may have provided information about the presence of dementia in some participants. However, our expectation that the implicit training method would be more effective was not confirmed, which makes it unlikely that there was a scoring bias.

The number of patients was rather small, so conclusions about training efficacy must be made cautiously and our results need replication in a larger sample. Furthermore, since our patient sample could be classified as having mild to moderate dementia, conclusions cannot be generalized to patients with more severe dementia. In mild or moderately severe dementia, it is possible that not only implicit memory is intact, but also that, although impaired, explicit memory function is available and was tapped by the patients during learning.\(^4\)

In our study, the patients simply needed to copy the actions of the trainer during the implicit training sessions, whereas in the explicit training sessions the patients had to make their own choices. Consequently, more mental effort was needed in the explicit training method, which may have positively affected the results and explain the positive results obtained with this training method. Mental effort has been shown to be important in rehabilitation in Alzheimer’s dementia patients\(^28\) and Alzheimer’s dementia patients learn better with a training method that requires mental effort than with a method that requires less mental effort.\(^29\)

Another explanation for the positive results obtained with both training methods is that it is not easy to distinguish between implicit and explicit learning during training sessions. As stated in the introduction, Willingham and Goedert-Eschmann\(^19\) suggested that
implicit and explicit learning always show a parallel course. Repetition is an important element in implicit training, and all participants practised the skills several times in succession in both training conditions. The performance after the explicit training method could also have benefitted from implicit knowledge acquired by repetition. Furthermore, during implicit training in our study, the participants often unintentionally muttered (rhetorical) comments about the actions the trainer made rather than simply repeating the action demonstrated, using explicit verbalization in this implicit training method. These verbalizations may have acted as verbal cues. Indeed, Ahlum-Heath and DiVesta demonstrated that using explicit verbal cues during learning enhances performance in healthy participants. Moreover, both tasks (Senseo and microwave) were explicit in nature, in that patients were aware that a task was being taught, even in the implicit training condition. All things considered, in clinical practice it is difficult to prevent ‘cross-contamination’ of explicit (verbal cues) and implicit learning (repetition) processes.

During implicit training the participants were prevented from making any errors, making it in essence a form of errorless learning. The theoretical framework underlying errorless learning is generally used as guiding principle in the cognitive training of people with dementia. Our study also shows that errorless training helps patients suffering from dementia to learn new skills.

Helping older people with cognitive deficits to retrain old skills and learn new ones may prolong their ability to function independently. The present study showed that people with mild to moderate dementia have considerable learning potential. It also demonstrated that, although useful for a better understanding of learning problems in dementia, the theoretical distinction between implicit and explicit learning might not be easy to make in practice. In future research, the ‘cross-contamination’ between explicit and implicit learning processes should be avoided as much as possible. For example, one could show participants videotapes of the required action and ask participants to learn the different steps by trying to memorize them in an explicit training procedure. In an implicit training procedure, participants could be asked to repeat the actions of the trainer while performing another mental task (such as mental arithmetic) to avoid explicit verbalization by the participants. Also, longer training sessions may be needed to determine whether patients with dementia can achieve a 100% performance score, which is needed in daily life. Furthermore, the concepts of error-less learning and effortful learning may help us to gain more insight into the underlying mechanisms of skill acquisition in dementia.

Clinical messages
- Older patients with mild to moderate dementia are able to learn new skills irrespective of the type of training (implicit or explicit).
- The theoretical distinction between implicit and explicit memory functions might not always be relevant for training procedures, since this distinction is difficult to make in practice.

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