Critical Review:
Effects of errorless learning on object naming and face-name associations in early-stage Alzheimer's disease

Sara Hansen
M.Cl.Sc. (SLP) Candidate
Western University: School of Communication Sciences and Disorders

This critical review examines the evidence regarding the effects of errorless learning on improving object naming and face-name associations among persons with early-stage Alzheimer's disease. A literature search was completed and yielded nine studies with the following research designs: nonrandomized clinical trial, within-subjects designs, single subject designs, and systematic reviews. Overall, the results of these studies demonstrate that errorless learning has beneficial effects on learning object names and face-name associations; however, a distinct advantage of errorless learning over other therapeutic methods has not been determined. The clinical implications of these findings as well as future recommendations are discussed.

Introduction

Alzheimer's disease (AD) is a neurodegenerative condition in which episodic memory and word finding become severely impaired over time, and significantly impact functioning in everyday life (Noonan, Pryer, Jones, Burns, & Lambon Ralph, 2012). However, it has been found that patients are able to acquire information (especially in the early stages), and once learned, it may be retained over some time (Metzler-Baddeley & Snowden, 2005).

Errorless learning (EL) is a therapeutic technique in which patients are prevented from making errors during learning, as compared to errorful learning (EF) where patients are encouraged to guess and generate answers if they are unsure (Metzler-Baddeley & Snowden, 2005). EL may be advantageous over EF in individuals with AD because this method utilizes implicit memory, which is a portion of memory that is intact in AD (Li & Liu, 2012). Currently, it is widely accepted that EL is a 'guiding principle' in cognitive training in individuals with dementia (including AD), and original experimental studies of patients with amnesia showed a distinct advantage of EL over EF (Mimura & Komatsu, 2007; Noonan et al., 2012). However, studies have yet to demonstrate a clear advantage of EL over other learning methods in patients with AD. Therefore, due to the impact that AD has on communication, and the increased rate of referrals for patients with neurodegenerative disease to speech-language pathology (SLP) departments, it is imperative that health care professionals are aware of the therapeutic methods that will most effectively enhance the communicative abilities of those with early-stage AD (Noonan et al., 2012).

Objectives

The primary objective of this paper is to critically evaluate the existing literature regarding the effects of EL on object naming and face-name associations in individuals with early-stage AD. The secondary objective is to offer evidence-based recommendations regarding the use of EL as a cognitive rehabilitation strategy within this population. Suggestions for further research will also be discussed.

Methods

Search Strategy

Computerized databases including PubMed and PsycINFO were searched using the following search strategy: (Alzheimer's disease) AND (errorless learning) AND (object naming). A review of reference lists of potentially relevant papers was also performed to ensure the completeness of the initial search.

Selection Criteria

Studies selected for inclusion in this critical review were required to investigate the effectiveness of EL on either learning or relearning face-name associations or object names in individuals with a diagnosis of early-stage AD. No limits were set on the demographics of research participants or outcome measures.

Data Collection

Results of the literature search yielded nine articles consistent with the aforementioned selection criteria: clinical controlled trial, non-randomized (1), within-subjects designs (4), singe subject designs (2), and systematic reviews (2).

Results

Clinical Controlled Trial (non-randomized)

Bier et al. (2008) compared the effects of five methods on learning face-name associations in 15 participants with early AD and 15 matched controls in a clinical controlled trial. Learning methods included: (1) spaced retrieval, (2) errorless learning, (3) vanishing cues, (4) trial-and-error (EF) with explicit memory task instruction and (5) trial-and-error with implicit memory task instruction. Selection of the participants with AD required specific inclusion and exclusion criteria and control participants were recruited based on word of mouth and advertising. Participants with AD were seen for ten 45-minute sessions, whereas controls were seen once or twice a week at their convenience. The authors state this was to reduce the time commitment and thus the attrition rate of control participants. With each method, participants learned five face-name associations, followed by free recall, cued recall, recognition, and delayed recall tests. Results showed that the AD group performed worse on all learning methods compared to controls, but all methods led to significant learning. This study showed that patients with AD are able to learn associations, even with the production of errors. Level 2b evidence is provided.

Limitations of this study include inconsistency with number of sessions between the groups, no true error-free EL condition, and short follow-up time (2 weeks). Having an EL condition that is not completely error-free makes it difficult to conclude that the EL condition did not lead to improved learning versus other methods. In addition, a control method was not employed in order to compare learning from the five training methods to the effect of no training. Despite these limitations, this is the only study that used control subjects for comparison. Thus, this study provides a suggestive level of evidence.

Within-Subjects Designs

Noonan, Pryer, Jones, Burns, and Lambon Ralph (2012) compared the effects of EL versus EF on object name relearning in eight participants with mild to moderate AD using a within-subjects design. Participants relearned names of previously known objects presented in two sets of 20 items. Gains on target words and a matched control set were assessed using confrontation naming at one and five weeks post-intervention. Appropriate analysis with 3x3 ANOVA revealed improvement for both EL and EF conditions at both assessment points. Results conclude that EL and EF are equally effective for object name relearning in patients with AD. This study provides Level 4 evidence.

A strength of this study includes the detailed neuropsychological assessment completed prior to commencement of intervention. Another strength is the direct comparison of EL and EF to a control condition. However, limitations include a small sample size and no blinding of assessors. Despite the limitations, this study provides a suggestive level of evidence.

Dunn and Clare (2007) compared the effects of four methods on learning and relearning face-name associations using a within-subjects, pretest-posttest design in ten participants with early-stage AD, vascular, or mixed dementia. The learning conditions were defined in terms of the amount of error and effort involved: paired associate (errorless and effortless), vanishing cues (errorless and effortful), target selection (errorful and effortless), and forward cues (errorful and effortful). Test items were 12 photographs of famous people whom the participants recognized but were unable to name and 12 matched novel faces. Participants were taught face-name associations under each condition in random order over six sessions. At the start of each session, baseline measures were obtained using free recall, cued recall, and visual recognition. After each session, testing was completed in the same manner. Repeated-measures ANOVA revealed higher post-intervention scores than baseline, but no significant difference in learning between EL and EF. The authors agree with the efficacy of memory rehabilitation techniques overall, but do not support the previously accepted view that reducing errors leads to improved learning of face-name associations in AD. This study provides Level 4 evidence.

Strengths of this study include randomization of testing trials for each participant. However, this study has a number of limitations. A small sample size was used and follow-up was limited. Control items were not used as a comparison of learning effects. A learned effect from each modality was not taken into consideration when interpreting the results (i.e., one modality influencing performance on another). Lastly, EL conditions were not completely error-free. These limitations impact the validity of results. Considering the strengths and limitations, a suggestive level of evidence is provided.

Metzler-Baddeley and Snowden (2005) compared the effect of EL versus EF on learning familiar and novel pictures in four participants with AD using a within-subjects design. First, patients relearned familiar objects they could no longer name. Then they learned novel face-name associations. The procedure was equivalent for both sets of material. Each set (2) in both conditions was repeated three times per day in random order for eight days. The experimenter conducted training for the first two days and completed baseline and post-training assessments using free recall after study sessions. The

experimenter explained the training to spouses of the participants, who completed the training for the remaining six days. They were given material to practice at home and record sheets to track performance. Combined data analysis showed a significant advantage of EL over EF for learning new and old information, but learning was also significant in the EF condition. Also, EL might be more beneficial in patients with more severe memory impairments due to the high level of difficulty associated with generating an answer in EF. This study demonstrates that patients with AD can learn old and new information with a slight advantage of EL over EF. Level 4 evidence is provided.

Limitations noted by the authors include the fact that the effect did not reach significance on the individual level (only upon combined data analysis), and the patients learned significantly in the EF condition as well. Although EL showed a slight advantage, both conditions are beneficial to learning. A description of training for spouses was not included and participants received varying amounts of time to study the sets. In addition, errors did not always occur in the EF condition. Lastly, factors other than errorlessness that may have caused learning were not controlled for. With the abundance of limitations, the results offer equivocal evidence.

Clare, Roth, Wilson, Carter, and Hodges (2002) evaluated the effects of an EL treatment paradigm on relearning face-name associations in 12 participants with minimal or mild AD in a within-subjects pretest-posttest design. Participants received training on one set of items and no training on a matched control set. Intervention occurred over six sessions, training one item per session in random order. Comparisons were made on free-recall and cued-recall trials at baseline, post-intervention, and follow-up assessments at one, three, six, and 12 months post-intervention for trained and control items. Repeated measures *t*-tests concluded statistical significance on free-recall trained items from baseline to post-intervention, but not on free-recall untrained items. Gains were largely maintained at six months follow-up on trained items, despite termination of practice one month after training. A similar pattern was found with cued recall scores. The authors also found that a greater awareness of the memory impairment led to improved learning. The results support previous findings that EL procedures are efficacious as a memory rehabilitation strategy. This study provides Level 4 evidence.

Strengths of this study include long follow-up time and thorough inclusion criteria. Also, having matched control items allowed for comparison of EL to no intervention, which enhances applicability of the results. Despite the strengths, the following limitations impact validity. There was a lack of experimenter blinding, which may have led to bias during testing. Comparison to another treatment method was not done. The authors also stated the importance for future studies to utilize neuroimaging data to explore underlying mechanisms of learning. Based on the strengths and limitations this study offers, a suggestive level of evidence is provided.

Single Subject 'n-of-1'

Clare, Wilson, Carter, and Hodges (2003) documented an individual with early-stage AD's ability to learn the names of 13 people in his support group, a topic that was personally relevant to him. A multiple-baseline-across-items single subject design was employed to assess the effectiveness of a combined training method using a mnemonic strategy with repeated presentation of the stimulus and expanding rehearsal in an EL paradigm. Follow-up assessment was completed immediately post-intervention, and one, three, and six months post-intervention. Results showed significant improvement with intervention, which was largely maintained at follow-up due to continued practice. Mean recall scores improved from a mean of 2.31% at baseline to 91.46% at follow-up. It is important to note that the items used in training were personally relevant to this patient, and his wife was highly involved in practice and training. This study shows the advantages for people with early-stage AD and their family members to employ learning strategies such as EL at home and demonstrates success of an individualized approach. This study provides Level 4 evidence.

A limitation includes the fact that the procedure was not entirely error-free, thus limiting the validity of the conclusions made. Also, it is unknown what at-home practice consisted of. However, the length of follow-up and randomization of order of training are strengths. This study provides a suggestive level of evidence in terms of the benefits of individualized therapy and the use of EL in early AD.

Winter and Hunkin (1999) conducted a preliminary examination to determine the effect of EL on relearning face-name associations in a single subject design. The patient was shown a series of photographs from the Famous Faces Test; ten faces that she was unable to name were chosen for training. Training occurred over four days using a two-trial session with an EL procedure. It consisted of providing her with pictures in random order, and instructing her to learn the names of each face. She was asked to name the person in each picture; she could say, "I don't know", and was discouraged from guessing. Testing consisted of a cued recall test before and after training each item. Results showed that she relearned the names of several people,

and doing so improved her ability to provide relevant information about them. This study concluded that EL has the potential to improve naming abilities in patients with AD. Level 4 evidence is provided.

Limitations of this study include incomplete methodology and incomplete results from the patient's neuropsychological assessment. Statistical analysis was not completed, so significance of results cannot be concluded. Lastly, there was a lack of follow-up, which makes it difficult to analyze treatment effects long-term. The authors also indicated the need for direct comparison with EF. This study lacks conclusive evidence due to its poor methodology and lack of statistical analysis, thus offers equivocal evidence.

Systematic Reviews

Li and Liu (2012) investigated the impact of EL on memory function in individuals with early-stage AD through the critical evaluation of four research papers. The evidence is tabulated in an efficient way for direct comparison between articles. The review concludes that the use of EL in memory rehabilitation for patients with AD is supported, but the more specific the learned information is, the greater the retention. In addition, using EL in a manner that capitalizes on implicit rather than explicit memory leads to greater learning. Lastly, EL shows more improvements in learning in patients with more awareness of their memory deficit. This review provides Level 4 evidence.

A limitation of this review includes no mention of multiple independent reviewers rating the studies while blinded to other ratings; however, the results are reported on and complete (i.e. aims, methods, results, and discussion). Therefore, this review provides a suggestive level of evidence for the efficacy of EL as a cognitive rehabilitation strategy in early-stage AD.

Mimura and Komatsu (2007) document the literature pertaining to the impact of cognitive rehabilitation methods on learning in patients with mild dementia (including AD). The review concludes that EL is a 'guiding principle' that may be beneficial for some people with early AD and that generalized cognitive training is effective against functional deterioration in these patients. Level 4 evidence is provided.

The primary limitation of this review is that a methodology section was not included, making it difficult to analyze the efficacy of the results. This review demonstrates equivocal evidence and a review that includes a complete methodology and results section is required to validate evidence in the literature.

Discussion

There were common methodological limitations present among many of the studies, which must be considered prior to forming an overall conclusion of the results. A small sample size was used in the majority of studies; most used fewer than 12 participants, with the exception of Bier et al. (2008). This limits generalizability of the results to individuals with early-stage AD as a whole. However, it is difficult to avoid a small sample size when studying learning ability in people with AD due to the inherent nature of this diagnosis. Another common limitation across studies was the use of an EL procedure that was not actually error-free. While participants were encouraged to say they did not know the answer if they were unsure, errors still occurred during EL conditions in studies by Bier et al. (2008), Dunn and Clare (2007), Metzler-Baddeley and Snowden (2005), and Clare et al. (2003). This limitation was also present in some studies included in the systematic review by Li and Liu (2012). This limits the conclusions drawn from these studies since it cannot be concluded that EL is or is not more beneficial than EF. The results from these studies should also be cautioned when considering application to clinical practice due to the standardized experimental procedures of training. Typically, there was a lack of practice following training, which is unrealistic in a therapeutic setting. The procedures employed in the studies are not guidelines for clinical use, as the methods are not ideal for long-term maintenance of learned skills.

While many of the studies used similar procedures for training of items (specifically the within-subjects designs), it is difficult to generalize conclusions due to the variability in outcome measures used to assess learning. Bier et al. (2008) and Dunn and Clare (2007) assessed learning using free recall, cued recall, recognition, and delayed recall tests. Noonan et al. (2012) assessed gains using confrontation naming at one and five weeks post-intervention. Metzler-Baddeley and Snowden (2005) and Clare et al. (2003) used free recall for baseline and delayed free recall for post-training assessment. Clare et al. (2002) used free recall and cued recall for baseline, post-intervention, and follow-up measures. Winter and Hunkin (1999) employed only a cued recall test before and after training. Based on the variation of outcome measures and timelines used to assess learning, it is difficult to make comparisons between studies as well as make on overall conclusion regarding the results.

Despite the common limitations found across studies, as well as the difficulty with generalizing results, there was an undeniable trend present in the findings. As a whole, the reviewed studies have shown that despite previous

assumptions, EL is not advantageous in comparison to other cognitive rehabilitation techniques in early-stage AD. While Clare et al. (2002) looked into the effects of EL compared to a control condition, Li and Liu (2012), Clare et al. (2003), and Winter and Hunkin (1999) considered the benefits of EL with no treatment comparison. Other studies compared the benefits of various treatment strategies, including EL (Bier et al., 2008; Dunn & Clare, 2007; Mimura & Komatsu, 2007), while Noonan et al. (2012) and Metzler-Baddeley and Snowden (2005) directly compared EL and EF. Overall, results showed that only Metzler-Baddeley and Snowden (2005) found a slight advantage of EL over EF on naming. The other studies generally found that EL is a beneficial learning technique for face-name associations and object naming in early-stage AD, but not more than other techniques.

Conclusion

Overall, the studies reviewed provide a suggestive level of evidence for the beneficial effects of EL on both object naming and face-name associations in individuals with early-stage AD. However, based on the evidence, EL is not considered to be advantageous over other cognitive therapy techniques, such as EF (trial-and-error learning). More research is required in order to determine the most effective learning method for individuals in the early stages of AD.

Recommendations

Based on the limitations of the above studies, it is recommended that further research be conducted on this topic and that it contain the following:

- Larger sample sizes, although this is difficult considering the population
- A true EL condition that is directly compared to EF and a control condition
- A randomized controlled trial; there is a need for direct comparison of the effects of EL versus EF (or other methods) in this population
- Increased follow-up time and number of training sessions to ensure long-term retention of information; this will improve clinical relevance of the procedure
- Focus on how results could improve autonomy in daily life and quality of life (QOL) in individuals with early-stage AD

Clinical Implications

It is recommended that SLPs use the evidence accumulated from the above reviewed studies with caution due to the limitations associated with the research. However, the overall findings are important to take into consideration when planning therapy to improve naming abilities in patients with early-stage AD. Although the majority of the findings lack specific guidelines for application of strategies to clinical practice, EL and EF are both considered appropriate strategies to improve object naming and face-name associations. Due to the variability of each individual with AD, SLPs are encouraged to plan therapy based on the strengths and weaknesses of each patient. While EL techniques are beneficial in some circumstances, clinicians should also consider other cognitive rehabilitation strategies when planning treatment.

References

Bier, N., Van Der Linden, M., Gagnon, L., Desrosiers, J., Adam, S., Louveaux, S., & Saint-Mleux, J. (2008). Face-name association learning in early Alzheimer's disease: A comparison of learning methods and their underlying mechanisms. *Neuropsychological Rehabilitation, 18*(3), 343-371.

Clare, L., Roth, I., Wilson, B.A., Carter, G., & Hodges, J.R. (2002). Relearning face-name associations in early Alzheimer's disease. *Neuropsychology, 16*(4), 538-547.

Clare, L., Wilson, B.A., Carter, G., & Hodges, J.R. (2003). Cognitive rehabilitation as a component of early intervention in Alzheimer's disease: A single case study. *Aging & Mental Health, 7*(1), 15-21.

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*(6), 735-754.

Li, R. & Liu, K.P.Y. (2012). The use of errorless learning strategies for patients with Alzheimer's disease: A literature review. *International Journal of Rehabilitation Research, 35*(4), 292-8.

Metzler-Baddeley, C. & Snowden, J.S. (2005). Brief report: Errorless versus errorful learning as a memory rehabilitation approach in Alzheimer's disease. *Journal of Clinical and Experimental Neuropsychology, 27*(8), 1070-1079.

Mimura, M. & Komatsu, S. (2007). Cognitive rehabilitation and cognitive training for mild dementia. *Psychogeriatrics, 7,* 137-143.

Noonan, K.A., Pryer, L.R., Jones, R.W., Burns, A.S., & Lambon Ralph, M.A. (2012). A direct comparison of errorless and errorful therapy for object name relearning in Alzheimer's disease. *Neuropsychological Rehabilitation, 22*(2), 215-234.

Winter, J. & Hunkin, N.M. (1999). Relearning in Alzheimer's disease. *International Journal of Geriatric Psychiatry, 14*, 983-990.