Research report

The effect of rivastigmine on connected speech assessed by the Boston Cookie Theft picture description task in patients with early Alzheimer's disease.

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Abstract

Background: Rivastigmine delays cognitive deterioration in patients with mild to moderate Alzheimer's disease (AD). Treatment with rivastigmine results in beneficial effects on cognitive function, ADL performance, global function and behavior, when a daily dose of 6-12 mg is used for at least six months. However, the effect of rivastigmine on connected speech is almost unknown.

Aims: This study aimed (i) to compare the connected speech of early stage AD patients with the connected speech of cognitively normal elderly people, and (ii) to compare the connected speech of the same group AD patients before and after treatment with rivastigmine.

Methods and procedure: Connected speech of AD patients (N= 28) elicited by the Boston Cookie Theft Picture Description Task was compared with that of healthy elderly volunteers (N=29). By using the same method, AD patients' connected speech was transcribed and analyzed before and after treatment with rivastigmine on six variables, namely number of essential concepts, total number of words, conciseness index, empty words, TTR-content words, and semantic paraphasias. Furthermore, we checked if the participants showed associative behavior, and if they gave comments on the picture.

Outcomes and results: This study demonstrated that there was no significant difference in connected speech performance of AD patients and controls. In addition, this study showed that the differences between assessment one and two of both groups were not significant for all variables.

Conclusions: The Cookie Theft Description Task is not a good method to discriminate between AD patients in the early stage and healthy elderly controls. It is furthermore demonstrated that rivastigmine positively affects connected speech of AD patients in the early stage, since they performed at an equal level at both assessments.

Keywords: Rivastigmine, connected speech, Cookie Theft, Alzheimer's disease,

Introduction

Alzheimer's disease (AD) is an unremitting illness and is characterized by degeneration of cholinergic neurons of the cortex and the hippocampus (Onor, 2007; Birks, 2007). However, cholinesterase inhibitors (ChEIs), such as rivastigmine, delay cognitive deterioration by reducing the breakdown of acetylcholine in the brain of AD patients (Kurz, 2004; Birks, 2007). This treatment results in beneficial effects on cognitive function, ADL performance, global function and behavior (e.g. Doraiswamy et al., 2001; Almkvist, 2004), when a daily dose of 6-12 mg is used for at least six months (Farlow et al, 2000; Schneider et al., 2000). Rivastigmine appears to be beneficial as a symptomatic treatment for patients in the mild to moderate stages of AD, while in the early stages the effect has not been attested (Storosum, 1999;, Bilikiewicz et al., 2002; Birks, 2007; Feldman et al., 2007). However, some researchers claim that there is no difference in improvement between the different stages of AD (Kurz et al., 2004). Visch-Brink et al. (2009) demonstrated that rivastigmine has a positive effect on spontaneous speech in patients with early AD.

It is currently difficult for clinicians to diagnose AD in an early stage, since there are no tests or imaging methods which can definitely determine Alzheimer's disease (Kawas, 2003). In a later stage, brain atrophy might be an important marker. Previous studies have investigated linguistic deterioration in patients with AD. They found that subtle language impairment can be observed relatively early in the disease process (Forbes-McKay & Venneri, 2005, Bucks et al., 2000; Vuorinen, 2000). As a result language deterioration could be seen as an early marker for AD, which could lead to better and earlier diagnoses.

The speech of people in the early stages of AD is often described as empty (Nicholas, 1985). This emptiness is a result of their lexical- semantic deficits, while their language remains structurally rich (Hier et al., 1985; Kavé et al., 2003). People with mild AD show similarities to the language impairment of people with anomic aphasia, while the speech of people with moderate to severe AD is more similar to Wernicke's aphasia (except for their phonemic distortions) or transcortical aphasia (Hier et al., 1985; Nicholas et al., 1985).

The language alterations of AD patients are generally assessed by specific and structured language tests (Prins et al., 2002; Bschor et al., 2001). However, these language tests do not seem to be sensitive enough to show the early language deficits in AD patients'

everyday language use (Bucks et al., 2000). The assessment of spontaneous speech is a more naturalistic way to investigate AD patients' daily use of language (Bucks et al., 2000; Prins et al., 2002). In addition, discourse analysis is an ecologically valid method to show the characteristic language deficits of AD (Bschor et al., 2001; Mahendra & Arkin, 2001). Discourse requires multiple complex mental functions and interaction of different linguistic levels (lexicon, syntax, phonology etc.) (Prins et al., 2002; Bschor et al., 2001). Therefore a spontaneous speech analysis might be sufficiently sensitive to assess patient's linguistic competence, since it could be that certain mental functions, and their interaction, are impaired in people with AD. Furthermore, recent studies have shown that spontaneous speech as well as connected speech analysis might be sufficiently sensitive to distinguish mild AD patients from cognitively normal elderly subjects (Nicholas et al., 1985; Forbes et al., 2002; Bucks et al., 2000). Connected speech, could be elicited by describing a picture description task, and is less time consuming than spontaneous speech (Prins et al., 2004). In addition, the Cookie Theft is often used as stimulus for eliciting connected speech production as part of several general assessments of aphasia (e.g. Prins et al., 2004). Clinical experts may choose for this more controlled type of discourse context, because connected speech will improve the generalization between subjects (Menn et al., 1993; Prins et al., 2004)). In other words, it is easier to make comparisons between subjects.

Many researchers claim that people with AD produce fewer essential concepts than elderly controls by analyzing their connected speech (Carlomagno et al., 2005; Croisile et al, 1996; Forbes et al., 2002; Forbes-McKay & Venneri, 2005; Hier et al., 1985; Kavé et al., 2003; Nicholas, 1985; Vuorinen et al., 2000). Besides the fact that their connected speech seems less informative, it is demonstrated that people with AD use also more indefinite and irrelevant information, when they describe the Cookie Theft picture (e.g. Croisile et al., 1996; Forbes et al., 2002; Kavé et al., 2003; Forbes-McKay & Venneri, 2005). Moreover, Nicholas et al. (1985) found that people with AD produced more deictic terms (words as *this, that, there, here*), empty words and pronouns without antecedent than controls. The speech of people with AD is therefore often described as empty and less concise. They have difficulty coming up with the appropriate word, and the result is that they use more general terms instead, for instance *a thing* instead of *a cookie* (Kavé et al., 2003). Similar to Nicholas et al. (1985), Kavé

et al. (2003) and Hier et al. (1985) showed that patients with AD had an increased use of pronouns and empty words which reflects the emptiness of speech. Furthermore Visch-Brink et al. (2009) demonstrated the increased use of empty words by analyzing spontaneous speech in patients with early stage AD. The increased use of indefinite irrelevant information and the use of fewer essential concepts makes the connected speech of AD patients less proper.

There is currently no considerable agreement about the total number of words produced by people with AD when describing the Cookie Theft picture. Nicholas et al. (1985) found that people with AD had the longest sample compared with controls. Kavé et al. (2003) found similar results. Furthermore, they found that AD patients used more words per clause compared with control subjects. In contrast, Hier et al (1985) and Croisile et al. (1996) found that AD patients used fewer words than healthy elderly to describe the picture and according to Bschor et al. (2001) AD patients and controls used an equal number of words. Another finding is that AD patients produce more semantic paraphasias than controls (Nicholas et al., 1985; Forbes et al., 2002; Kavé et al.,2003). However, Croisile et al. (1996) found no difference in the use of semantic paraphasias between controls and people with AD. Both groups produced them.

The purpose of the present study was to find out on which features we can distinguish connected speech of AD patients from the connected speech of normal elderly. Given previous research, we predicted that the Cookie Theft is sensitive enough to discriminate the connected speech of AD patients from healthy elderly. Secondly, we would like to investigate whether rivastigmine has (a positive) influence on specific features of the connected speech of people with early stage AD, since the effect of rivastigmine on connected speech is almost unknown. The sparse literature about the effect of rivastigmine has pointed that it positively affects connected speech of AD patients in the early stages (Visch-Brink et al., 2009). On this basis, we hypothesized that rivastigmine keeps the connected speech of AD patients at least stable during the second assessment. This means that no difference in assessment one and two as well as a better second assessment indicates that rivastigmine could have a positive effect on connected speech of AD patients in the early stages, although we do not know how their connected speech would be without

rivastigmine. However, we predicted that AD patients' connected speech will decline over time, without treatment with rivastigmine.

In sum the aim of this article is: (i) to compare the connected speech of early stage AD patients with the connected speech of cognitively normal elderly people, and (ii) to compare the connected speech of the same group AD patients before and after treatment with rivastigmine.

Methods

Participants

Connected speech of twenty-eight patients with early stage probable AD, who started taking rivastigmine, was compared with that of twenty-nine healthy elderly volunteers (Table 1).

All patients, recruited from the Memory Clinic of the Erasmus University Medical Centre (EUMC), were included in the' experimental group' if they were at least 65-years-old. AD patients and their main representatives gave written informed consent to participate in this study. All patients were asked to complete the Dutch version of the Mini-Mental State Examination (MMSE) (Folstein, Folstein & McHugh, 1975). Only patients with a MMSE-score between 16 and 30 were included. Dementia was diagnosed on the DSM criteria (APA, 1994). The patients used rivastigmine for at least six months. Some patients used only capsules, and some patients used patches after a while due to adverse events. Later on, all patients started with treatment by patches, because of less adverse events. Patients using patches started with a dose of 6 milligram a day, and patients taking capsules started with a daily dose of 3 milligram a day. This 3 milligram was gradually increased to 6 or 12 milligram. Although patients differ in using capsules or patches, the effect is the same because they used the same dose of rivastigmine.

All elderly volunteers came from the neighborhood of Rotterdam, and included the so-called 'normal group'. They were included if they were older than 65 years and cognitively healthy. For both groups, participants were excluded if they suffered from (other) neurological disorders, reversible dementias, CVA-history, psychiatric disorders, and/or language- and speech problems. They all were native speakers of Dutch.

Table 1.
Characteristics

	AD patients	*Controls*
N	28	29
Gender (M/F)	11/17	14/15
Mean age (yrs)	77	75
Mean MMSE	25	

Procedure

The examiner presented the subjects the Cookie Theft picture (Figure 1) and gave the following instruction: *'Tell all about what you see going on in this picture'* (Boston Diagnostic Aphasia Examination, Goodglass & Kaplan, 1972).

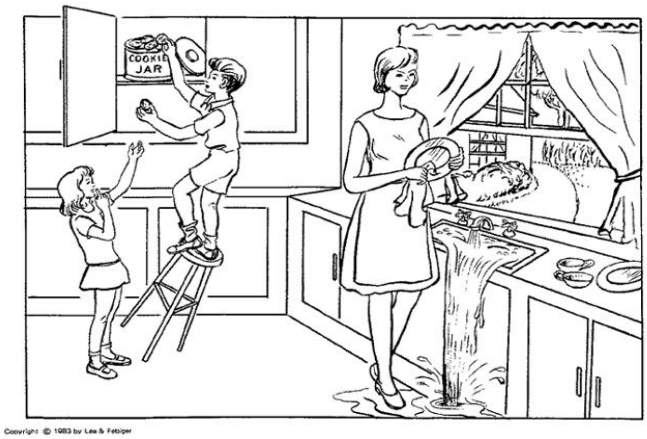

Figure 1. Cookie Theft Picture Description Task (Goodglass & Kaplan, 1972)

The picture description was collected on a tape recorder by different speech/language pathologists/linguists in the patient's homes. For both groups there was a first and second speech sample collected. During both assessments the same picture was used, because it is more reliable to compare both samples. The interval between the first and second sample was (at least) six months, with a maximum interval of a year. For the experimental group the first sample was collected preceding treatment with rivastigmine, and the second sample after treatment with rivastigmine.

Scoring

Each collected sample is transcribed and analyzed by a linguist, according to a protocol with six fixed variables. The variables were *essential concepts, global length of sample, conciseness index, empty words, TTR-C* and *semantic paraphasias*. Furthermore, we observed if the participant showed *associative behavior.* In addition, we analyzed if the participant gave subjective *comments* on the picture. All variables will be explained below.

1. *Essential concepts.* According to Croisile et al. (1996) and Kavé et al. (2003), 25 possible information concepts were determined in four categories: Actors, Places, Objects and Actions. The category Actors included the mother, the boy and the girl (or children instead). The category Places included the kitchen and the exterior seen through the window. The category Objects included the faucet, the water, the sink, the floor, the plate, the dishes on the counter, the counter, the cookies, the jar, the cabinet, the stool, the window, and the curtain. The category of Actions included the boy taking/stealing the cookie, the boy/stool falling, the mother drying/washing the dishes, the water overflowing, the girl asking for a cookie, the mother unconcerned by the overflowing, and the mother not noticing the children. Participants were given a point for mentioning an essential concept.

2. *Global length of the sample* was measured by the total number of words produced in each sample.

3. Following the *conciseness index* of Hier et al. (1985) we measured the conciseness of the sample of each participant. A conciseness index was calculated as the ratio: 100x (essential concepts/total number of words used in the sample).

4. *Empty words,* this variable demonstrated how many empty words the participants used. Empty words contribute no content to a coherent description of the target picture and/or are non-specific words denoting persons, time, place, actions (e.g. *something, somewhere, and so on*) (Visch-Brink et al., 2009; Nicholas, 1985).

5. *Type-Token Ratio-Content words (TTR-C),* is the number of different content words/total number of content words. With this variable we looked at the lexical

diversion of all content words in the samples: nouns, adjectives, (informative) adverbs and independent verbs.

6. *Semantic paraphasias* are existing words that are distant semantically related to the target word (e.g. chair for stool) (Nicholas et al., 1985).

Statistical analyses

1. For the comparison of both connected speech samples of the AD patients, a paired-samples t-test is carried out. The same is done for both connected speech samples of the control group. A paired-samples t-test compares assessment one and two within one participant. In order to find out if the number of indefinite terms increased or not, a Wilcoxon test is used for both groups. The number of semantic paraphasias has been described, instead of a statistical analysis, since the minimum number was 0, and the maximum was only 2.

2. In order to find out if the connected speech of the experimental group differ significantly from the connected speech of the control group, an independent t-test is carried out, for both assessment one and two for each parameter. An independent t-test measures if there is a (significant) difference in means of a specific parameter between both groups. A Mann-Whitney-White is carried out for the empty words variables of sample one and two.

Results

Difference in connected speech between AD patients and controls

The difference in performance between the experimental group and the controls was assessed during two assessments for each variable with the independent t-test. All variables demonstrated no significant difference in group performance (Table 2).

Table 2. Group differences

	Assessment I			*Assessment II*		
	T-value (df)	*Mean (SD); AD*(N=26)/C ** (N=29)*	*Significance (two tailed)*	*T-value (df)*	*Mean (SD); AD*(N=28)/C ** (N=29)*	*Significance (two tailed)*
Total Words	,306 (53)	84,35 (33,4)/81,69 (31,0)	,761	,914 (55)	86,04 (33,6)/78,31 (30,2)	,365
Nr. of concepts	-,113 (55)	10,14(3,4)/ 10,24 (3,1)	,910	-,297 (55)	9,25 (3,5) /9,52(3,3)	,768
Conciseness index	-1,104 (55)	12,35 (4,8)/13,86 (5,5)	,275	-,912 (55)	11,68 (5,3)/ 12,77 (3,6)	,366
TTR-C	-,592 (48)	,88 (,10)/,89 (,07)	,556	-1,413 (46)	,88 (,10)/,91 (,06)	,164

* the patients with Alzheimer's disease , the experimental group.

** the control subjects, the normal group.

In addition, the Mann-Whitney White showed no significance for empty words between groups at assessment one (Z= -,611, P = > 0,05) and assessment two (Z=-,411, P = > 0,05). AD patients had an average rank of 27,64 at assessment one, and controls had an average rank of 30,31. At assessment two the average rank was 28,09 for the AD patients, and 29,88 for the control subjects.

Table 3 shows what the frequency was for the semantic paraphasias per group.

Table 3. Descriptives of semantic paraphasias

	Assessment I		*Assessment II*	
Nr/Group	***AD***	***C***	***AD***	***C***
0	19	25	18	26
1	8	4	9	2
2	1	-	1	1
Total nr paraphasias	9	4	10	3
Mean/pp	,32	,14	,36	,10

Difference between assessment one and two per group

No significant difference was found between assessment one and two for each variable (Table 4).

Table 4. Assessment differences

	AD (N=26)			***Controls(N=29)***		
	T-value (df)	*Mean (SD); 1/2*	*Significance (two tailed)*	*T-value (df)*	*Mean (SD); 1/2*	*Significance (two tailed)*
Total Words	,352 (25)	84,35(33,4)/ 82,19	,728	,622 (28)	81,69 (31,0)/78,31 (30,2)	, 539
Nr. of concepts	1,742 (27)	10,14 (3,4) /9,25 (3,5)	,093	1,126 (28)	10,24 (3,1)/9,52 (3,3)	,270
Conciseness index	,694 (27)	12,35 (4,8) /11,68 (5,3)	,493	1,135 (28)	13,86 (5,5)/12,77 (3,7)	,266
TTR-C	-,108 (27)	,8789 (,10)/ ,8814 (,10)	,915	-1,724 (28)	,8912 (,07)/,9124 (,06)	,096

For the variable empty words no significant difference has been found between assessment one and two for the experimental group (Wilcoxon test, Z= -,229 P = > 0,05) and for the controls (Wilcoxon test, Z = -1,077 P = ,282). The AD patients had an average rank of 14,50 at assessment one, and 10,39 at assessment two. The control subjects had an average rank of 12,27 at assessment one, and 10,39 at assessment two.

Associative behavior and comments

Furthermore, we analyzed how much associative behavior (Table 5) and how many comments (Table 6) each group had on the picture. It was analyzed if associative behavior is present or not, but external stories (with participant's their own experiences) were not counted in the sample. Thus, it did not have influence on the variables, for instance the conciseness index.

Table 5. Descriptives of associative behavior

	Assessment I		*Assessment II*	
Nr/Group	***AD***	***C***	***AD***	***C***
-	23	24	25	25
Present	5	5	3	4
Mean/pp	0,18	0,17	0,11	0,14

Table 6. Descriptives of comments on the picture

	Assessment I		*Assessment II*	
Nr/Group	***AD***	***C***	***AD***	***C***
-	16	16	16	9
Present	12	13	12	20
Mean/pp	0,43	0,45	0,43	0,69

Discussion

Difference in connected speech between AD patients and controls

Firstly, in this study it was aimed to compare the connected speech of early stage AD patients with the connected speech of cognitively normal elderly people. We predicted, on the basis of earlier studies, that the Cookie Theft was sensitive enough to discriminate connected speech of AD patients from the connected speech of healthy elderly people. This research provides no evidence for any statistically significant difference in connected speech performance of AD patients and controls, and is therefore not in line with earlier studies and

our hypothesis. The Cookie Theft description task did not seem to be a good method to discriminate between AD patients and the control group apparently. Specifically, connected speech elicited by the Cookie Theft could not be used to diagnose AD earlier, since it did not discriminate AD patients from healthy elderly people.

Recent studies indicated that the speech of AD people is emptier than controls, because AD patients used more indefinite and irrelevant words. However this study contradicts earlier findings, since both groups used an equal amount of indefinite and irrelevant words to describe the Cookie Theft by making use of empty words. Furthermore, many studies demonstrated that AD patients used fewer essential concepts than controls (Carlomagno et al., 2005; Croisile et al, 1996; Forbes et al., 2002; Forbes- McKay & Venneri, 2005; Hier et al., 1985; Kavé et al., 2003; Nicholas, 1985; Vuorinen et al., 2000), whereas this research demonstrated no significant difference between AD patients and control subjects.

Researchers do not agree about the fact if AD patients use more or less words than normal healthy elderly to describe the picture. The outcomes of this research are in line with Bschor et al. (2001) in which there is no significant effect found for the number of words used, between both groups. This means that AD patients as well as healthy elderly volunteers needed the same amount of words to describe the picture.

Even though Hier et al. 1985 found that the conciseness index was lower for AD patients compared with healthy elderly volunteers, there is no difference found in the conciseness index in this research. Because no difference has been found between AD patients and controls in essential concepts and total number of words, accordingly the conciseness index is also equal for both groups. Moreover, the difference between AD patients and controls for the TTR-C was also not significant, while Hier et al. (1985) found that AD patients' speech showed a reduction in lexical diversity for the AD patients.

If we look at the mean scores of both groups however (Table 2), it stands out that we could see a certain pattern. The control subjects had always higher mean scores than the experimental group for the number of concepts, the conciseness index and the TTR-C, as noticed earlier. This means that the mean scores do show a trend that tends to confirm earlier studies, in which the researchers claimed that controls performed better than AD patients. Furthermore, AD patients had a higher average number of total words than

controls. This tends to be more in line with the studies of Nicholas et al. (1985) and Kavé et al. (2003). In addition, the mean scores show that the control group produced more empty words than the experimental group during both assessments. This contradicts the fact that the AD patients use more empty words, since it is claimed that they have a semantic deficit. However, the differences between both groups are very succinct, and as discussed already, they are not significant.

Table 3 shows that the mean number of paraphasias per participant was higher for AD patients compared with controls at assessment one as well as assessment two. This would mean that AD patients produced more semantic paraphasias than control subjects. The total number of paraphasias per group was almost the same at both assessments, in particular for the AD patients 9-10 and for control subjects 4-3. Thus, the difference between assessment one and two per group is nihil, since the difference is only one paraphasia less or more. These descriptives tend to be in agreement with the research of Nicholas et al. (1985), Forbes et al. (2002), and Kavé et al. (2003), in which AD patients produced more semantic paraphasias than healthy volunteers, despite we do not know if the difference in number of paraphasias is significant.

Difference between assessment one and two per group

We investigated the difference between the connected speech of AD patients before and after treatment with rivastigmine. We presumed that without the use of rivastigmine, connected speech of AD patients will decline over time, since the degeneration of the cholinergic neurons of the cortex and the hippocampus. The differences between assessment one and two of the AD patients were not significant for all variables. We suppose therefore that because of not finding a significant difference between the two assessments, both samples of the AD patients are comparable. This would mean that their connected speech performance did not decline over six months, which is in agreement with the fact that treatment with rivastigmine delays cognitive deterioration.

This study indicates that rivastigmine does not only affects connected speech the mild and moderate stages but also in the early stages (Storosum, 1999;, Bilikiewicz et al., 2002; Birks, 2007; Feldman et al., 2007), and is in line with the finding that rivastigmine

positively affects spontaneous speech in the early stage (Visch-Brink et al. 2009), since it keeps the connected speech of assessment one and two stable.

Although the mean scores indicated that AD patients used: fewer concepts, and less words after treatment with rivastigmine, the differences were not significant. In addition, the mean scores of the conciseness index demonstrated that AD patients' speech was less concise during the second assessment, but again this difference was not significant.

In addition, the differences between assessment one and two for the control group were not significant as well. In other words, they did not show improvement, thus both samples are comparable. Therefore we presume that there is no learning effect for using the same picture during both assessments. However, the same trend in mean scores of fewer concepts, less words and less concise speech during the second assessment, could be seen in the results of the control group as well. This demonstrates that the AD patients as well as the healthy volunteers had higher scores during the first assessment compared with the second. For the total number of words, it would not say that using fewer words is automatically less good. But also the conciseness index and number of essential concepts is lower during the second assessment for both groups. On the contrary, for both groups the TTR-C increased in the second sample compared with the first. This would indicate that their speech was more lexically diverse in the second sample. However, it is conceivable that every participant performs differently at independent moments, even though it is the same method and the same person. Moreover, the differences between both assessments are very small and not significant.

Associative behavior and comments

It is worth mentioning that the participants showed associative behavior and gave comments during the assessments. Therefore, we checked if this behavior and these comments were presented or not. First we checked if participants of both groups tend to show associative behavior (Table 5). In other words, if they told external stories, in which they described how they experienced the same events in the past as the figures in the picture. Furthermore, they sometimes imagined that they were playing a role in the picture as well and as a consequence they described the picture as if, for example, their own mother

was doing the dishes. This is the reason why we made the distinction between the agent and the action in the essential concepts variable. If participants mentioned the right action but mentioned the wrong agent, they only got a point for the action. Table 5 shows the descriptives of associative behavior present in the samples. In the samples of assessment one, there were five participants who showed associative behavior in both groups. During assessment two, three participants of the AD patients, and four participants of the control group showed associative behavior. Thus, not a lot of participants showed this behavior. However, it is surprising though; that participants talked about their own experiences if they were asked to describe what is going on in the picture.

In addition, Table 6 shows the number of participants who gave comments on the picture. AD patients' average number of comments per participant was equal for both assessment, namely 0,43. For the control subjects the average number of comments increased during the second assessment, namely from 0,45 (13 participants) to 0,69 (20 participants). It could be that 'older' people in general tend to give more subjective comments on the picture, because they might want to make clear the morality of the picture, according to the life experience they have. Where the older people have the idea to tell the message of the picture besides the description, maybe younger people just describe objectively what is going on in the picture. Further studies should investigate that research question in the future.

Summary and/or conclusions

Firstly, in this study we wanted to find out if we can discriminate the connected speech of early stage AD patients with the connected speech of cognitively normal elderly people. The results of this study demonstrated that there is no difference in connected speech performance of AD patients and controls, and the Cookie Theft Description Task is therefore not a good method to discriminate between AD patients in the early stage and healthy elderly. AD patients are often described as if they have lexical-semantic deficits. The outcomes of this study are not in agreement with prior studies, in which there is evidence that lexical access is impaired compared with healthy elderly.

Secondly, we wanted to investigate if there is a difference in the connected speech of

the same group AD patients before and after treatment with rivastigmine. Besides the beneficial effects on cognitive function, ADL performance, global function and behavior, rivastigmine positively affected the performance of the AD patients' connected speech, since it did not decline over time. In other words, during assessment two, AD patients performed as good as during the first assessment.

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