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Language performance in bilingual patients with neurodegenerative dementia: Preservation of first language?

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Table of contents

Abstract

Nowadays, many people use several languages in their everyday life. As a result, a lot of patients with neurodegenerative dementia are bilingual. This raises complex questions regarding language impairment in this population and how best to assess and rehabilitate it.
Cerebral representation of languages and language impairment in bilinguals has become an interesting topic of research.
In this study, we assessed 21 late-bilinguals patients with dementia and compared their results to 19, cognitively healthy, matched controls to study L1 preservation.
Our results suggest that L1 is not better preserved in patients with neurodegenerative dementia. Interestingly, we demonstrated a better preservation of comprehension in L2 in our global population, regardless of the dementia. This points to the role of immersion in language preservation.

1. Introduction

1.1 Epidemiological background

Switzerland has welcomed many immigrants from various nationalities over the last 70 years and the foreign-born population represents more than a fifth of the whole population (22.8% in 2011). (2) As of consequence of immigration and in conjunction with its own internal migration and four national languages, Switzerland now hosts a large population of multilinguals, and in particular late multilinguals.

At the same time, the population is aging. In 2011, 17.2% of the population was older than 65 years old. (2) This causes a massive increase in the incidence of dementia. In 2010, 125'000 people had a diagnosis of dementia in Switzerland. (3)

Therefore, the number of bilingual patients suffering from dementia is increasing. This raises complex questions regarding language impairment in this population.

1.2 Bilingualism and cognitive processes

Definition

Bilingualism has many definitions. The definition often used in neuroscience has been suggested by François Grosjean, Professor at the University of Neuchâtel and specialist in neurolinguistics: "Bilingualism is the use of two (or more) languages in one's everyday life." (4)

The monolingual view of bilingualism sees a bilingual person as the addition of two monolinguals, with two distinct sets of language abilities. As a consequence, "real" bilingualism has been described as the ability to speak two languages equally well. The "wholistic" view of bilingualism, on the other hand, sees bilingualism as an integrated whole which cannot be separated in two languages. The language system is different and is not the sum of two language systems. The two languages are often used in different contexts for different purposes. For this reason, the abilities in both languages are often different and language expertise depends on different variables such as age of acquisition, immersion and proficiency. (5)

Bilingualism can also be characterized, by age of acquisition, context and frequency of language use (L1 versus L2 or L2 versus L1).
Simultaneous or early bilingualism refers to the simultaneous learning of several languages from birth. Consecutive, successive or late bilingualism refers to the later learning of another language, usually after 6 or 7. (6)

Cerebral representations

The influence of the acquisition of several languages on cortical organisation is complex. Many hypotheses have been proposed and tested in clinical research, particularly in the field of stroke research.

First of all, there is the possibility that all languages spoken by an individual share the same cortical loci and brain representation. This would mean that there is only one global cerebral representation for language in general, as opposed to several differentiated cerebral representations for each language. In this case, an injury to the language area of the brain should impact similarly on all languages. (7)

On the other hand, the possibility of independent linguistic systems for each language has also been discussed. In this situation, the two languages of a bilingual individual could be affected in a different way by brain damage, depending on the localisation of the lesion and the divergence between cerebral representations of both languages. (7)
In particular, it has been suggested by some authors that the various languages could be represented in completely different areas of the brain or could be in partly different areas and overlapping. (7) While the dominant speaking hemisphere is known to place an important role in language in the majority of people independently of their language status, a differential lateralisation of the languages has also been suggested, with greater involvement of the non-dominant hemisphere in the second language representation and processing in bilinguals. Supporting this theory, a study on late Macedonian-English bilinguals using functional MRI, showed that bilingual subjects had a greater bilateral activation. (7), (8)

In the stroke research area, variable patterns of impairment and recovery have been observed in bilingual patients. This would favour the hypothesis describing separate and specific cerebral representations for each language. (7). However, in the majority of cases of cerebral injury, parallel recovery of both languages was observed, where the patient recovers both languages at the same time and to the same extent. On the other side, some cases showed differential recovery. These patients recovered one language better than what was expected according to the premorbid proficiency. In other terms, the less well-spoken language before the stroke was better recovered. (9), (10)

Furthermore, in some specific pathologies, the first language (L1) seems to be more preserved than the later-acquired languages (L2). For example, in some psychiatric disorders such as schizophrenia, symptoms may be more important in an L1 environment. During acute psychosis, patients might not be able to communicate at all in their second language. The impact of the language used on the behaviour and symptomatology of psychiatric patients could again point towards a different organisation of languages in the brain. (11)

Finally, the manner and the age of acquisition as well as the use of a language also seem to influence cerebral representation. A negative correlation between age of acquisition and L2 proficiency was observed in several studies. (12)
L1 is acquired implicitly by a child, in an intuitive way, whereas L2 is usually taught explicitly at an older age. As a result, the neural structures processing language knowledge are different for L1 and L2. (13),(14)
L1 is learnt during a critical period at a young age. The initial hypothesis on this critical period claimed that language has to be acquired before puberty, in order to be fully developed. This hypothesis was based on the assumption that the brain loses its plasticity over time. (15), (16)

The declarative/procedural model

Declarative memory controls explicitly learned aspects of language, such as vocabulary or grammar rules, while procedural memory regulates implicit linguistic competence, namely

more automatic aspects of language. These types of memories are represented in different area of the brain.
Following this theory, the phonological and morpho-syntactic aspects of L1 are controlled by procedural memory, whereas vocabulary and grammar learned in school depend on declarative memory. If a second language is acquired early enough and used often, it may also be subserved by the procedural memory system and be used automatically. On the other hand, if L2 is acquired later, its learning process will rely more on declarative memory and the subject will speak his L2 consciously using grammar rules and vocabulary learned at school instead of relying on automatic linguistic competence. (17)

1.3 Neurodegenerative dementia and language impairment

Language impairment is, after episodic memory and executive deficit, an early symptom of Alzheimer's disease. Lexico-semantic aspects of language are affected first in the disease process. Word-retrieval difficulties are common, impacting on speech fluency. Naming, written language and comprehension can also be affected. Automatic aspects of language are classically preserved longer. (11), (18), (19), (20)

Language impairment becomes more prevalent with increased severity of the dementia. Early-onset dementia and rapid disease progression are factors associated with language impairment. (20)

Aging itself has been associated with a decline in bilingual proficiency. (21), (19) Because of the decreasing concentration and attention seen in the elderly, normal aging tends to affect language performance. (22) For this reason, it is difficult to distinguish the impact of aging on language performance from a specific effect of a neurodegenerative dementia.

In bilinguals with neurodegenerative dementia, it is still not clear whether the two languages are affected in the same way and at the same time.
Patients may begin to show a preference for their first language, despite previous fluency in the other language. We hypothesise that late bilingual patients with neurodegenerative dementia develop an asymmetrical language impairment, where the first language is better preserved.

Several factors could favor this asymmetrical language impairment.

First of all, in order to communicate in one language, the bilingual patient has to inhibit the other language. This controlling ability can be altered in patients with dementia, resulting in involuntary intrusion of the dominant language during conversation in the other language. (19) The decrease in bilingual language control could be explained by the decrease in cognitive control observed in old age. (23)

Likewise, bilinguals with dementia may have difficulties in choosing the right language depending on the context and inappropriate switching can occur. (24) This is related to the ability to control language mode.
Language mode can be described as "the state of activation of the bilingual's languages and language processing mechanisms at a given point in time." It can range from no activation to total activation and the two languages can be activated simultaneously. In bilingual mode, one language remains activated and the other one is activated as well. This occurs when two

bilinguals communicate and switch from one language to the other. In monolingual mode, one language is deactivated. This happens when speaking with an interlocutor who only speaks one language. Patients with dementia may lose control over language mode and be unable to stay in a monolingual mode to suit their interlocutor or the situation. (5)

Moreover, because of the way memories are created, earlier memories may be connected with the first language, whereas later memories will be associated with the language used when the experience was lived, either L1 or L2. (11) Since earlier memories are better preserved in dementia, one could expect the associated L1 to be more protected from cognitive decline.

In addition, the procedural and declarative memory system is a determining factor in the use and hence the loss of language. (10)
Alzheimer's disease tends to affect declarative memory first, while procedural memory is preserved longer. (18) As described above, a late bilingual relies more on declarative memory and the use of L2, which is consequently less automatic and less efficient than L1 use. (12)

These elements support the hypothesis of selective L2 language impairment in the early stages of the disease in late bilinguals.
However, other patterns of language impairment in bilinguals with dementia have been described.

Notably, in a study on early, high-proficient Catalan-Spanish bilinguals with Alzheimer's disease, increasing severity of the disease was associated with lower performance in picture naming and word translation. However, in this study, both languages were similarly affected. In this case, neurodegeneration apparently affected both languages in the same way. (22)

Finally, the opposite hypothesis, namely a greater sensitivity of L1 to cognitive decline in dementia, has also been described. In a study on elderly English-Spanish bilinguals, both early and late bilinguals had higher naming scores in their non-dominant language, suggesting a greater sensitivity of L1 to Alzheimer's dementia. (25)

The present study aims to investigate a possible better preservation of L1 in some modalities of language in bilinguals with neurodegenerative dementia. Recent pilot study showed parallel impairment of both languages regardless of the age of acquisition of L2. However, we wanted to specify these results by repeating the process on a larger group of participants.

We will also compare the patients' results with those of the control group, to see if the difference between L1 and L2 is bigger in patients suffering from dementia.
Finally, we will test the correlation between immersion and use of L2 and global results.

2. Method

The study was approved by the local Ethics Committee (*Protocol 279/11*). All subjects were given appropriate information and signed an informed consent form.

2.1 Population

The study was conducted on 21 patients (13 females) and 19 controls (11 females). The patients and controls were recruited through the Neurology Departments of the hospitals of Fribourg, Lausanne and Geneva, Switzerland.
Some of the subjects had been tested in a pilot study, in a publication process in the academic journal "*Bilingualism: Language and Cognition". (26)*

The patients had a clinical diagnosis of degenerative or mixed dementia, diagnosed by cognitive neurologists. Sixteen had probable and three possible Alzheimer's type dementia, one had a mixed Alzheimer's and vascular dementia and one had dementia associated with Parkinson's disease.
All patients had acquired French as a second language (L2) after the age of seven. Their first language (L1) was German for fifteen patients, Spanish for two and Italian for four.

Patients with unaided sensory disorders, other causes of dementia, major psychiatric disorders or other major illness were excluded from the study.

Results were compared to 19 cognitively intact bilinguals. These controls fulfilled the same bilingualism criteria. Thirteen had German as L1, two Spanish and four Italian.

2.2 Language assessment

The *Mini Mental State Examination (MMSE)* (27) was used to assess global cognition .

Language abilities were assessed in all patients and controls in different aspects of oral comprehension and production, both in L1 and L2.

The following tests were used during the language assessment:

Boston Diagnosis Aphasia Evaluation (Goodglass & Kaplan, 1972)

→ Oral comprehension:

- Verbal discrimination: identifying images of 6 objects, 6 actions, 6 shapes, 6 symbols, 6 colours and 6 figures named by the examiner.
- Orders' execution: understanding and performing an oral command (15 items).

→ Oral expression:

- Oral naming: naming of 6 objects, 6 actions, 2 shapes, 6 symbols, 6 colours, 6 figures, and 3 body parts.
- Automatism: counting up to 21, naming the days of the week and the months of the year.

The Isaacs SET test (Isaacs & Kennie, 1973)

→ Semantic fluency: the patient is required to produce as many words as possible from the following categories: colours, animals, fruits and towns, changing every 15 seconds.

Bilingual Aphasia Test (Paradis, 1987)

The full BAT (BAT) consists of three main parts:
- Evaluation of the patient's multilingual history
- Assessment of language disorders in each language spoken by the patient
- Assessment of translation abilities

For this study, we selected the following subtests of the BAT:

→ Oral comprehension:
- Syntactic comprehension: selecting the image that matches the orally presented sentence (51 items). This measures the patient's ability to understand sentences on the basis of their syntactic form.

→ Oral expression:
- Repetition of words and logatomes associated with a lexical decision task: the word is presented orally, the patient repeats it and then has to say whether the word exists or not (30 items).
- Repetition of sentences: repeating the sentence spoken by the examiner (7 items).

Aphasia in multilingual patients raises complex issues regarding assessment (which test to use) and treatment (uni- or multilingual). In most cases, the patients are only examined in the language of the hospital, thus only giving part of the clinical information. (7)

The BAT enables a systematic assessment of the different linguistic skills in each language spoken by a bilingual individual. The test is carefully adapted to each language, linguistically and culturally, and is not a mere translation of the original. In order to compare communicative capacities in the different languages of the patient, an identical assessment tool has to be used for all languages. (28)

The BAT is culturally sensitive. It compares language abilities between the two or more languages spoken by the individual. In a clinical setting, it shows which language is best preserved. (29)

2.3 Study design

The study was a prospective single two-center analysis. A number was assigned to each subject for anonymisation.

2.4 Experimental procedure

Subjects were seen twice, as one language was tested at a time, between October 2013 and June 2014. Several examiners were involved, to ensure when possible that the examiner was fluent in the assessed language. The examiners were affiliated to one of the three hospitals involved and were used to administer such tests.

Time between L1 and L2 testing ranged from the same day to two weeks apart. During the second part of the testing, 5 patients and 4 controls were tested in L1 first and the rest of the subjects were tested in L2 first.

Subjects were asked to fill a language background questionnaire. This questionnaire was filled with the help of a relative when possible. They were asked about the age of L2 acquisition and the duration of immersion in a French-speaking area. The languages known and used to communicate with their parents and partner were listed.
They were asked to assess daily use of both languages in percentage, as children (language spoken at home, at school) and as adults (language used at work, to watch television, to read a book). Proficiency in L2 was self-assessed on subjective scales for speaking, understanding, reading and writing and was rated in percentage.

2.5 Data analysis and statistics

These results were added to a group of 13 patients and 12 controls already tested with a similar protocol for a pilot study. Results were analyzed using IBM SPSS Statistics Software.

Due to the small sample and the group distribution of the bibliographical data, we used non-parametric tests for the statistical analysis.
At the group level, we compared the patients' and controls' performances in different language tasks in both languages with a Mann&Whitney comparison test.

Language performances were calculated individually for each linguistic task for patients and controls in L1 and L2. Then, comparison between groups (patients versus controls), language (L1 versus L2) and interactions was calculated through a repeated measure ANOVA with performance as the variable, group as intersubject factor and language as intrasubject factor. The statistical significance of the ANOVA was set, after Bonferroni correction, at $p = 0.025$ for the global scores (*Table 2a*); for the individual scores, level of significance was set at <0.001

We also studied the correlation between the number of years spent in a French-speaking area and the use of L2 during adulthood with the global L2 performance.

3. Results

The 21 patients and 19 subjects were respectively 75.5 years, $\pm$ 5.6, and 69.1 $\pm$ 8.5 years old. (P-Value .323). There was no difference in their level of education, and all were late bilinguals (> 7 years old). The mean age of L2 acquisition was slightly higher in controls (20.4 years old) than in patients (14.7 years old). The control group had a higher mean MMSE score (28/30) than the patient group (20/30), which confirms that patients were indeed cognitively impaired and that controls were in the normal range.
In terms of bilingualism, subjects were considered proficient in L2, as the results described in *Table 2* show.

Table 1 – Linguistic characteristics

	Dementia patients		Control subjects		P values
	Mean	SD	Mean	SD	
Level of expertise of L2 (French)					
Speak L2 (%)	85.2	14.07	80.42	11.75	.258
Understand L2 (%)	88.55	12.31	86.32	13.22	.588
Write L2 (%)	57.55	32.63	61.26	28.98	.710
Read L2 (%)	76.55	24.79	75.68	23.60	.912
Childhood before 6 years					
L1 taught at school (%)	87.5	30.89	98.68	5.74	.129
L1 spoken by students (%)	82.5	37.26	100	0	.048
L1 spoken at home (%)	92.5	23.08	100	0	.165
Frequency of use of L2 in adulthood					
At workplace (%)	62.63	29.64	63.16	31.59	.958
Watching the television (%)	51.25	30.86	52.63	26.21	.881
Speaking with friends (%)	66.25	21.88	61.84	31.59	.614
Reading a book (%)	42.89	33.35	51.32	29.43	.415
History					
Number of years spent in a French-speaking country	55.24	14.28	44.24	8.71	.011

Table 2 – Language performances and comparisons between L1 and L2

Controls scored better than subjects (group effect). Global score did not show any difference between L1 and L2 for the whole population, nor did global oral expression score (language effect). However, global scores for oral comprehension showed a main effect of language, with better results for global comprehension and syntactic comprehension in L2 than in L1 in these elderly subjects. Even so, the interaction was not significant, indicating that this better preservation of L2 comprehension existed for both populations, patients and control. There was no specific effect of Alzheimer's disease on language compared to healthy old subjects.

Table 2a

Language Test	Controls L1	Controls L2	Patients L1	Patients L2	Main effect of group (patients – controls)	Main Effect of language L1 – L2)	Interaction
Global Oral Production	Mean: 173.63 SD: 9.59	Mean: 172.05 SD: 8.10	Mean: 144.33 SD: 24.59	Mean: 143.19 SD: 30.24	F: 20.779 P-Value: .000	F: 0.595 P-Value: .445	F: .015 P-Value: .902
Global Oral Comprehension	Mean: 163.08 SD: 6.07	Mean: 161.03 SD: 4.70	Mean: 136.83 SD: 19.70	Mean: 141.69 SD: 17.90	34.681 P-Value: .000	87,827 P-Value: .000	1.485 P-Value: .231

Table 2b

Language Test	Controls L1	Controls L2	Patients L1	Patients L2	Intersubject Main effect of group (patients - controls)	Intrasubject Main Effect of language L1 - L2)	Interaction
Verbal discrimination (BDAE)	Mean: 70.97 SD: 1.93	Mean: 71.24 SD: 1.51	Mean: 63.21 SD: 8.22	Mean: 64.40 SD: 7.66	F: 21.621 P-Value: .000	F: .521 P-Value: .475	F: .212 P-Value: .648
Automatism (counting) (BDAE)	Mean: 3 SD: 0	Mean: 3 SD: 0.45	Mean: 2.90 SD: 0.30	Mean: 2.90 SD: 0.43	F: 2.625 P-Value: .113	F: 0 P-Value:1	F: 0 P-Value: 1

Oral naming (BDAE)	Mean: 102.05 SD: 4.12	Mean: 103.47 SD: 3.42	Mean: 88.95 SD: 16.45	Mean: 88.14 SD: 22.05	F: 10.49 P-Value: .002	F: 067 P-Value: .79	F: .896 P-Value: .35
Orders' execution (BDAE)	Mean: 14.63 SD: 0.60	Mean: 14.79 SD: 0.42	Mean: 11.81 SD: 3.19	Mean: 11.67 SD: 3.21	F: 19.589 P-Value: .000	F: .001 P-Value: .981	F: .221 P-Value: .641
Fluency (Isaacs set Test)	Mean: 32.47 SD: 7.89	Mean: 29.58 SD: 5.96	Mean: 20.38 SD: 8.15	Mean: 19.38 SD: 8.70	F : 23.78 P-Value: .000	F : 4.465 P-Value: .310	F : 041 P-Value: .310
Syntactic comprehension (BAT)	Mean: 48.05 SD: 3.08	Mean: 45.74 SD: 3.45	Mean: 37.9 SD: 8.36	Mean: 38.90 SD: 6.69	F: 24.303 P-Value: .000	F: .948 P-Value: .336	F: 5.449 P-Value: .025
Repetition of words and logatomes (BAT)	Mean: 29.26 SD: 0.93	Mean: 29.21 SD: 1.13	Mean: 26.24 SD: 3.62	Mean: 27.33 SD: 2.20	F : 13.1 P-Value: .001	F : 4.01 P-Value: .052	F : 4.86 P Value: .034
Lexical decision (BAT)	Mean: 29.42 SD: 1.43	Mean: 29.26 SD: 0.87	Mean: 25.71 SD: 3.59	Mean: 26.71 SD: 3.24	F: 29.014 P-Value: .000	F: .511 P-Value: .479	F: .965 P-Value: .332
Sentences repetition (BAT)	Mean: 6.84 SD: 0.37	Mean: 6.83 SD: 0.38	Mean: 5.86 SD: 2.06	Mean: 5.43 SD: 1.75	F: 24.30 P-Value: .000	F : .948 P-Value: .336	F: 5.44 P-Value: .025

Table 3 – Immersion

We calculated the correlation between L2 immersion and the difference between the global scores for L1 and L2 (L2-L1) for global oral comprehension.

L2 immersion was calculated as the mean of the use of L2 in different settings (percentage of L2 spoken at work, to watch television, to read, to speak with friends reported by the subjects).

Pearson's Correlation	-.065
Significance	.693
N	30

4. Discussion

In this study, we compared language performance in patients with neurodegenerative dementia to cognitively healthy controls, in their first language (L1) and in their later-acquired second language (L2). In order to assess language in these two populations, we used extracts of well-recognised tests including the Bilingual Aphasia (Paradis, 1987), the Boston Diagnosis Aphasia Evaluation (Goodglass & Kaplan, 1972) and the Isaacs SET test (Isaacs & Kennie, 1973)

Our results show:

- a group effect, with a difference between the two populations in favour of the control group;
- an absence of interaction between group and language, indicating that L2 was not more impaired in the dementia group compared to the elderly control;
- a language effect in the comprehension modality, suggesting that in this mixed population, regardless of their cognitive impairment, comprehension was better preserved in L2.

Group effect

The group effect between dementia and control confirms the expected language impairment in the dementia patients group.

Although symptoms vary between the different types of dementia, language impairment affects all patients in the early stages of disease progression. In Alzheimer's disease, language impairment typically starts with word evocation difficulties. In later stages, patients show oral (and written) expression and comprehension impairment. In severe Alzheimer's disease, all modalities of language are affected. Because of its specific impact on semantic memory, Alzheimer's disease affects primarily the production capacity and comprehension of words. As a result, patients with Alzheimer's disease often score poorly in naming tasks, even early in the course of the disease. (30) In our population, 19 out of 21 patients had possible or probable Alzheimer's disease.

Absence of interaction between group and language

The absence of interaction suggests that L2 is not necessarily more sensitive to neurodegenerative disorders, and in particular Alzheimer's disease, than the first language.

We had hypothesized a better preservation of L1 compared to the later-acquired French, for several reasons. Amongst other things, we expected the impact of dementia on the ability to control language mode and inhibit one language when speaking the other to put one language at a disadvantage. (5), (19) Besides, we anticipated the language learned earlier to be better protected from cognitive decline, by analogy with the different types of memory and the loss of recent memories in Alzheimer's disease. (11) Also, we suspected L2 to be more sensitive to the declarative memory decline seen in neurodegenerative dementia. (18) This hypothesis was not verified, as our results show no main effect of language.

Several studies have reached the same conclusion.
A study designed to assess the impact of Alzheimer's disease on the two languages in early,

high-proficient Catalan-Spanish bilinguals showed no difference, in lexico-semantic tasks. These results suggest that both languages of an early bilingual are equally sensitive to neurodegenerative diseases impacting on lexico-semantic language abilities, such as Alzheimer's disease. (22)

In another study on Spanish-English bilinguals with Alzheimer's disease, there was no significant interaction between group and language. The subjects scored similarly in L1 and L2 for verbal fluency from a semantic category. (31)

Another research team studies Catalan-Spanish bilinguals with Alzheimer's disease using the Bilingual Aphasia Test and observed similar results in both languages. (18)

These different studies all showed a parallel impairment of both languages in bilingual patients with neurodegenerative dementia, which is consistent with our findings. However, these studies mainly focused on early bilinguals, unlike the present study.

Language effect

Our results show an unexpected result, with a better preservation of global comprehension in L2, regardless of the dementia. This indicates that understanding skills are better in L2 compared to L1, independently of the neurodegenerative condition, which does not appear to have a specific effect on language.

This result points to the role of immersion. Living in a French-speaking area for years seems to have a greater influence on language preservation in old age then dementia. Most of our subjects had immigrated in a French-speaking area as young adults and settled there. They often had francophone spouses and worked in a french setting.

Bilingual people often learn and use languages in different settings. As a result, they usually don't have the exact same skills and knowledge in both languages. (5) For example, one may use English at work and have more work-related vocabulary in English than in the first language. In our population, both controls and patients were proficient in L2.

Several factors influence language skills. The language history is obviously important. Where was the language learned, when, etc. But other factors later in life can influence language. The everyday use plays a major role. (5) An immigrant might only use his first language when travelling back to visit his family. In this case, the first language will not be used in the everyday life and language of the host country might become more important.

These results are consistent with those of the pilot study, namely a main effect of group with poorer performance of the dementia group, no main effect of language with similar performance in L1 and L2 and no interaction between group and language showing an equal impact of neurodegenerative dementia in both languages. (26)

Limitations

These results must be interpreted with caution, as this study has several limitations.

First of all, the number of participants was limited, due to difficulties in recruiting people who fulfilled our inclusion criteria.
A lot of bilingual people in Switzerland learn both languages early on, typically when one parent comes from the German-speaking area and the other from the French-speaking area. These people could not be included, as they were considered early bilinguals.

Working with dementia patients was challenging. Because of the cognitive impairment, information had to be given to a relative to obtain consent. Some of the relatives we contacted were concerned about the tests being too demanding for the patients. It is true that the limited attention span did interfere with the tests with some patients, in which cases we had to interrupt the testing for them to rest. This reduced attention span may have had a negative impact on the second language tested, when both languages were tested in the same session.

The assessment of the pre-morbid L2 proficiency was self-assessed and subjective. Our results cannot differentiate what skills were lost from what was never acquired.

By using the same examiner for the two sessions, we placed the patients in a bilingual mode. They knew they could communicate with the examiner in both languages and code-switching and borrowing were thus made acceptable. It is difficult for an examiner to pretend to be monolingual when they understand the other language. (5) These factors influence the subject, who will be more prone to switching and might score poorly in his weaker language as a result.

As regards German-speaking participants, testing in German was done in standard German, although officially, the subjects' first language was the Swiss German dialect. However, this probably only had a marginal impact, as Swiss German-speakers still use standard German for all written aspects of language, education and as their official language.

There was an important variability in the age of acquisition, as well as in the duration of the immersion in a French-speaking area. Besides, the use of L1 was highly variable, going from daily use to a few times a year. These differences lead to imprecisions when comparing subjects. Nevertheless, all participants had a similar bilingual background, with a late acquisition of L2.

5. Conclusion

This study was conducted on 40 late bilinguals, who had acquired French after the age of seven. Both languages were assessed in 21 patients with a diagnosis of neurodegenerative or mixed dementia and 19 cognitively healthy matched controls.
Language assessment was carried out using extracts of the Bilingual Aphasia Test and the Boston Diagnosis Aphasia Evaluation, as well as the Isaac's SET test.
Results were analysed using a Mann&Whitney comparison test and a repeated measure ANOVA.
In our population, we found a main group effect, no group-language interaction and a language effect for L2 comprehension.

These results contribute to a better understanding of language impairment in bilinguals. This is important in order to define how to assess and rehabilitate language deficits in bilingual patients.

Further research in this direction could explore the role of the age of acquisition and of immersion on language preservation.

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