Chapter 6

Bilingual lexical access and aging: Evidence from verbal fluency data.

Abstract

Studies on lexical access show conflicting results on verbal fluency tasks, with either no significant difference in scores for monolinguals and bilinguals or a bilingual disadvantage. Additionally, research involving elderly monolinguals has shown that aging usually has a negative effect on verbal fluency performance, but it is as of yet unclear what exactly happens to the lexical access of bilingual speakers in older age. In order to investigate both mono- and bilingualism and the age factor in verbal fluency tasks this study compared verbal fluency data from middle-aged and elderly Frisian-Dutch bilinguals to that of age-matched German monolinguals. Bilinguals were found to produce as many words as monolinguals on both fluency conditions, i.e., there was no sign of a bilingual disadvantage. On phonological fluency there seemed to be a negative age-related effect for the monolinguals only: elderly monolinguals performed significantly worse than their middle-aged counterparts, whereas both bilingual age groups performed equally well. Besides overall performance on semantic and phonological fluency we examined the use of clustering and switching to gain more insight into the processes underlying bilingual lexical access and age-related effects on verbal fluency. Analysis of clustering and switching indicates that these strategies are used similarly by monolinguals and bilinguals.
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6.1. Introduction.

Within the field of research on bilingualism, one question that has interested scholars for many decades now is that about the potential advantages and disadvantages of using more than one language on a regular basis. In particular, there are still uncertainties about how the status of being a bilingual might affect both linguistic and non-linguistic cognitive abilities of bilingual speakers. Moreover, researchers want to find out what effect bilingualism, especially from early childhood on, might have on verbal and cognitive development in older ages.

Recently, various studies have demonstrated positive effects of bilingualism on cognitive abilities of bilingual children and adults (for reviews see Adesope, Lavin, Thompson & Ungerleider 2010; Hilchey & Klein 2011). These advantages on non-verbal tasks are said to be a direct result of the constant switching between languages of bilinguals and the experience they have in activating words from one language, while at the same time inhibiting words from the other language. On the other hand, bilinguals were sometimes found to show disadvantages on tasks that require more linguistic processing, such as verbal fluency or picture naming tasks (Gollan, Montoya & Werner 2002; Ivanova & Costa 2008). This phenomenon is often explained by the idea that when bilinguals access words in their one language, they experience interference from their other language, which affects their lexical access in terms of speed or accuracy (Hermans et al. 1998; Costa et al. 2003). However, not all studies show consistently lower performance of bilinguals on tasks testing lexical access. (Rosselli et al. 2000; Portocarrero, Burright & Donovick 2007). Therefore, researchers still want to gain more insight into the determining factors of bilingual lexical access, compared to that of monolinguals. In order to answer questions concerning the
effect of bilingualism on age-related cognitive development, comparisons are made between bilingual speakers of different age groups or with different degrees of bilingualism (e.g. early vs. late bilinguals).

This study compares middle-aged and elderly bilingual and monolingual speakers in their performance on the verbal fluency task. The verbal fluency task is a test method in which participants have to verbally produce as many words as possible within a given amount of time (usually 60 seconds). The most common distinction is made between semantic or category fluency and phonological or letter fluency. On the semantic verbal fluency task, participants are asked to produce as many words as possible from a certain category (e.g. animals, plants), whereas on the phonological fluency task, they have to produce as many words as possible beginning with a certain letter/sound (e.g. the letters s or p). The verbal fluency task simultaneously requires rapid lexical access but also calls for a high demand of executive control. The more controlled processes of the verbal fluency task include the use of effective search strategies, the monitoring of memory output, meaning the words that have already been produced, and the inhibition of irrelevant or misleading lexical items (Luo, Luk & Bialystok 2010).

In the present study we investigated whether middle-aged and elderly bilingual speakers are different in their verbal fluency performance when compared to monolinguals of the same age groups. Additionally, we want to study what exactly happens to lexical access in bilingual aging. Apart from an analysis of overall performance in verbal fluency, this study tries to find out whether analysing different processes within verbal fluency, such as the occurrence of clustering and switching, can help explain strategy differences between bilinguals and monolinguals on this task. The term clustering refers to the phenomenon that
frequently, words that are produced during this task turn out to be semantically or phonologically related, which means that they are retrieved in clusters. As this is not always the case though, participants also tend to switch between clusters or produce words that are not related at all. This phenomenon is referred to as switching.

6.2. Verbal fluency in monolinguals and bilinguals

Different versions of the verbal fluency task have been widely used for various purposes. However, the analysis and interpretation of verbal fluency scores have been challenging for many researchers because of the complexity of the task itself. To begin with, the two different kinds of fluency tasks are often said to rely on different cognitive processes (Troyer, Moscovitch & Winocur 1997; Rosselli et al. 2000; Gollan et al. 2002). Whereas semantic fluency scores are said to be more influenced by organization of semantic knowledge, phonological fluency is said to rely mainly on strategic search processes and executive function (Portocarrero et al. 2007; Sauzéon et al. 2011).

Moreover, as mentioned earlier, phonological fluency is often referred to as the more effortful and difficult task (Filippetti & Allegri 2011), because of its unusual nature of required word activation. On the phonological fluency task, participants have to suppress the habit of using words related to their meaning (Perret 1974), which is different from lexical retrieval during natural speech. On the semantic fluency task, items are activated within a semantic field, which might facilitate lexical access. Another reason that is mentioned by Filippetti and Allegri (2011) is that the production of words in the phonological condition requires the search within more subsets of semantic categories as compared to the semantic condition. Apart from that, semantic fluency is mostly limited to
nouns and often only concrete words (Rosselli et al. 2000), whereas words in phonological fluency can also be function words, words from different word classes and abstract words. With regard to other factors that might influence performance on the verbal fluency task, the study by Troyer (2000), providing data of 411 healthy adults between the ages of 18 and 91, found that higher levels of education were always associated with better fluency performance, regardless of the type of fluency task. This shows the importance of including participants’ level of education as background measure when comparing verbal fluency performance of different groups.

In research on bilingual verbal fluency performance many studies similarly report a bilingual disadvantage, indicating a bilingual deficit in lexical access and rapid word retrieval (Gollan et al. 2002; Bialystok, Craik & Luk 2008; Portocarrero et al. 2007; Sandoval, Gollan, & Ferreira 2010). Sandoval et al. (2010) reported several results reflecting this bilingual disadvantage. First of all, bilinguals produced fewer correct responses and had slower first response times. Furthermore, they showed proportionally delayed retrieval and more cross-language intrusion errors when speaking the non-dominant language.

Identifying the underlying reasons for these findings however, has turned out to be particularly challenging, as studies report diverging results regarding the different fluency tasks (semantic vs. phonological). Some studies only found lower performance of bilinguals on semantic fluency, with equal scores on phonological fluency (Rosselli et al. 2000; Portocarrero et al. 2007). These authors usually explain their findings by arguing that semantic fluency is mainly based on the activation of lexical representations and retrieval of concrete words (Rosselli et al. 2000). As bilinguals have words in two languages for these
shared representations (e.g. *cat* in English and *gato* in Spanish when naming animals), there is said to be a higher level of language interference during this task. This is not the case in the phonological condition, where semantic representations play a less important role in task performance. A study by Gollan et al. (2002) led to results that might support this idea. Even though bilinguals were outperformed by monolinguals on both tasks, the difference was larger on semantic fluency.

Other research on bilingual verbal fluency performance yielded more confusing results, at least at first sight. Bialystok et al. (2008) found that even though there was no difference in performance between mono- and bilinguals on semantic fluency, it was the monolingual group that outperformed the bilinguals on phonological fluency. However, when they controlled for vocabulary size, these differences disappeared. This is not surprising, as bilinguals were found to have a smaller vocabulary (per language) when compared to monolinguals (Craik & Bialystok 2006; Fernandes, Craik, Bialystok, & Kreuger 2007).

Another factor that Bialystok et al. (2008) included in their study was that of executive function. Previous research on bilingual children had found that bilingualism might be related to improved efficiency of executive control (Bialystok, 2001). Similar results were found for middle-aged and older bilinguals, in an experiment involving the Simon Task (Bialystok et al., 2004). These results suggest that bilinguals might be able to compensate for disadvantages in lexical access, in those tasks that rely heavily on executive control, such as phonological fluency. A few studies mentioned previously, in which a bilingual disadvantage was absent in the phonological condition (for instance Rosselli et al. 2000; Portocarrero et al. 2007) seem to corroborate this idea.
One attempt to reveal the underlying mechanisms that might cause the often-found bilingual disadvantage on verbal fluency was made by Sandoval et al. (2010). They consider three different potential explanations for slower lexical access in bilinguals. First of all, the disadvantage could be due to interference from the non-target language. The idea behind this is that during bilingual processing, when one language is used, the other language remains active and has to be inhibited (Green 1998), leading to slower retrieval of words in the target-language. Another explanation for why bilinguals might have slower lexical access is simply that they use each of their languages less frequently (‘weaker-links account’), which means that lexical items in each language are activated less often than in the case of monolinguals. The third hypothesis proposes that bilinguals might be slower in retrieving words because they have smaller vocabularies in each of their languages, which reduces their selection of target words in production tasks like the verbal fluency tasks and thus slows down lexical retrieval. In their study, Sandoval et al. (2010) mostly found indications for the interference-between-languages hypothesis, although not all of their results support this account.

Apart from interference between languages, we might argue that there is also competition for selection within one language during the verbal fluency task. This means that even during monolingual verbal fluency performance, multiple concepts are activated by one semantic cue (e.g. a category like animals) and lexical items have to be selected individually, while competitors have to be inhibited. The additional activation of another language implies that bilinguals have to face an extra level of selection demand. In addition to within-language competition of related semantic concepts, bilinguals also have to deal with cross-language competition for lexical activation.
The effect of language interference appears to be most prominent for high-frequency words (Gollan, Montoya, Cera, & Sandoval 2008). Sandoval et al. (2010) gave the example that most Spanish-English bilinguals would probably know the word for “carrot” in both languages, whereas they might know the word for “eggplant” in only one language. However, bilinguals also showed higher overall performance on phonological fluency. Sandoval et al. (2010) explain this by the higher demands of executive control on phonological fluency.

Summarizing previous findings on bilingual verbal performance, one of the more consistent results is a general bilingual disadvantage in tasks requiring lexical access and controlled retrieval of lexical items. Moreover, this disadvantage is usually bigger on semantic fluency. On the one hand this is thought to be due to higher levels of language interference on this condition than on phonological fluency. On the other hand, this discrepancy between performances on the two conditions may reflect compensation mechanisms used on the phonological task. This task taps most heavily into executive control functions, particularly those which reportedly are enhanced in bilinguals (Hilchey & Klein 2011). The other finding that stands out from research on bilingual verbal performance is that the effect of language interference seems to be one of the factors causing bilingual deficits in lexical access, although aspects such as frequency of use and reduced vocabulary might also be of importance. All in all, bilingual verbal fluency performance can be described as the product of two countervailing processes (lexical activation and executive control), which makes it particularly difficult to tease apart the effects of the underlying cognitive functions during this task.
6.3. Different processes of verbal fluency performance

For a long time, the only measurement of verbal fluency that studies used for their analyses was the total number of words generated within the time period of 60 seconds. Several researchers however, have acknowledged the complexity of processes involved during word retrieval on the fluency task (Gruenewald & Lockhead 1980; Wixted & Rohrer 1994) and described a two-stage cycle of processes during semantic fluency. First, participants have to search for subcategories of a particular category (e.g. birds within the category animals) and then they have to search for specific items within that category (e.g. sparrow, seagull as examples of birds). Whenever items within a subcategory are exhausted, the participants have to stop the current search process and initiate a new one within a different subcategory. This analysis of the processes at work during lexical retrieval suggests that there are not only spurts of semantically related items but also distinct breaks between those spurts (Unsworth, Spillers & Brewer 2011).

Troyer et al. (1997) were among the first to argue that because of the multifactorial nature of the verbal fluency task, using only the total word score would not suffice to capture all aspects of an individual performance on this task. For that reason, they wanted to conduct a more qualitative, in-depth analysis of verbal fluency performance, by examining the amount of clustering and switching that occurs during trials. This kind of method is in line with ‘process’ approaches in neuropsychological testing, which deal not only with level of performance of subjects but also with the strategies participants use to perform a particular task (Abwender, Swan, Bowerman, & Connolly 2001). Troyer et al. (1997) defined semantic clustering as spurts of lexical items from the same subcategory, e.g. birds within the category animals. Phonological clusters were successive words beginning with
the same two letters or sounds (e.g. ball, bar), different only by the vowel sound (e.g. bit, bat, but), words that rhymed (e.g. man, van) or words that were homonyms (e.g. some, sum). They counted the number and size of semantic clusters on semantic fluency, number and size of phonological clusters on phonological fluency, as well as the mean cluster sizes for both conditions. Switches were calculated as the number of transitions between clusters and single words. Besides, they also included repetitions and errors in their analysis of clustering and switching, as they were thought to add to the understanding of underlying cognitive processes, regardless of their exclusion for the total number of words (Troyer et al. 1997).

Troyer et al.’s study (1997) has important implications for the processes involved in clustering and switching. According to Troyer et al. (1997), clustering is considered a rather automatic process compared to switching, which they see as a more effortful and strategic search process. Regarding the production of clusters on phonological fluency however, it is doubtful to what extent this way of clustering reflects the same mechanism of lexical activation as clustering on semantic fluency. As the retrieval of words that fulfil the conditions of a phonological cluster as defined by Troyer et al. (1997) is a rather unusual way of lexical retrieval, it cannot be assumed that clustering on phonological fluency reflects a more automatic process. Rather, it seems likely that phonological clustering is more associated with strategic and controlled processing than with automatic or subconscious activation of words, as participants on this task seem to consciously use the retrieval of phonologically related words as a strategy for successful performance.

Even though several studies that included clustering and switching in their analysis (Filippetti & Allegri 2011; Unsworth et al. 2011; Sauzéon et al. 2011) have based their
methodology on that of Troyer et al. (1997), there are also critical voices regarding Troyer et al.’s scoring method (1997). Abwender et al. (2001) agree that a qualitative examination of verbal fluency performance, i.e. looking at clustering and switching, seems inevitable when trying to understand the underlying cognitive processes of the task. A main point of criticism that Abwender et al. (2001) discuss are the limitations of the switching construct that Troyer et al. (1997) use in their analysis. Abwender et al. (2001) raise the question whether the cognitive processes involved when switching from one multi-word cluster to another might be different from those processes that are used when switching between unrelated and non-clustered words.

Furthermore, they challenge Troyer et al.’s (1997) assumption that switching reflects strategic searching and mental flexibility and imply that it might also be caused by lack of the ability to cluster and reflect limited access to phonological or semantic subcategories (Abwender et al. 2001). This might especially be the case for switches between nonclustered words. For this reason Abwender et al. (2001) introduced two distinct ways of switching. They use the term cluster switches to refer to transitions between adjacent and overlapping clusters, where clusters need to contain at least two related items. Switches between a cluster and a nonclustered word or switches between two nonclustered words are called hard switches (Abwender et al. 2001).

The idea behind this distinction is to have a construct of switching, namely cluster switching, which is closer to the switching construct as explained by Troyer et al. (1997), and is said to reflect strategic shifting and mental flexibility. Abwender et al. (2001) concluded that a single measurement of the switching component might be insufficient to reflect the complexity of the switching process. With regard to semantic fluency they found
that hard switching had a negative effect on overall performance, which indicates that hard switching may indeed reflect impaired or limited access to semantic subcategories (Abwender et al. 2001).

Summing up, previous research on clustering and switching on the verbal fluency task shows general agreement that with regard to semantic fluency clustering is a more automatic process than switching and is mainly related to activation of subcategories and lexical storage. Switching on semantic fluency on the other hand is a more controlled process as it includes the activation of words from a different subcategory than the previously mentioned words. For phonological fluency, it can be assumed that the process of clustering is a more controlled and strategic one than on semantic fluency, as words are usually not activated within phonological categories. Switching within phonological fluency is also more related to cognitive flexibility and processing speed. Apart from that, in order to measure switching as a product of intentional strategic word retrieval, it seems to be necessary to make a distinction between hard switches and cluster switches.

6.4. Age-related effects in monolingual and bilingual verbal fluency

Another factor that affects performance on the verbal fluency task is aging. Acevedo et al. (2000) found that increasing age was always associated with lower fluency scores on all of their semantic fluency trials (animals, vegetables, and fruits). Similar results were found by Troyer (2000) for both semantic and phonological fluency performance. In a previous study by Troyer et al. (1997) however, they did not find an age-related difference on phonological fluency. Yet another study (Ostrosky, Ardila & Rosselli 1999) found the opposite effect, namely that age was a more influential factor on phonological fluency than
on semantic fluency, but it was always the case that younger participants outperformed older participants. As studies report different effects of age on the fluency conditions, it is difficult to make assumptions about the exact reasons for the age-related disadvantage. Regarding age effects in verbal fluency, an analysis of clustering and switching revealed interesting new insights. Troyer et al. (1997) found that the age-related deficit in older adults seems to be due to lower switching scores, whereas they found no age effect on amount of clustering, although older people tended to create larger clusters than younger people on phonological fluency. Similar results were reported by Kavé, Kigel and Kochva (2008) who found that age-related increase of verbal fluency scores of participants between the age of 8 and 17 was merely due to an increase of switching scores, with no age-driven difference in clustering. These findings imply that the often-found age-related effect on verbal fluency might mainly be caused by age-related decline in the efficiency of executive functions and not necessarily by deficits in semantic knowledge or retrieval thereof. This view is shared by Sauzéon et al. (2011), who investigated the age-related decline in verbal fluency both with regard to clustering and switching. Their results indicate that even though the older participants did not have lower overall performance on semantic fluency, they did show lower performance on the non-semantic component (switching) of the task.

A number of studies on bilingualism (Bialystok, Craik & Ryan 2006; Author 2014) have also focused on the effect of bilingualism on age-related linguistic and cognitive development. One central question here is whether the constant use of more than one language could have the positive effect of delaying cognitive decline in older ages. This question is based on the idea of use-dependent functional changes of the brain. Bialystok et al. (2008) report findings of other researchers who found that people who regularly engaged in specialized activities, e.g. playing video games or a musical instrument showed increased
performance in executive functions. It is implied that training in certain activities can cause changes in the underlying brain structures and processes (Bialystok et al. 2008).

A question that derives from this is whether those use-dependent changes in the brain can actually improve activities that go beyond those that were regularly trained. The fact that in some studies bilinguals were found to have advantages in non-linguistic cognitive tasks, which may have been a result of linguistic activities, could therefore possibly serve as support for this assumption (Bialystok et al. 2004). But what happens to this potential bilingual advantage in older age? From research on monolingual aging, it is known that both cognitive control and lexical access decrease with older age (McDowd et al. 2011).

What Bialystok et al. (2004) found in their study of younger and older bilinguals was indeed that the advantage in executive control seemed to remain into older adulthood, or more specifically, that this advantage was even greater for the older group of bilinguals. They concluded that bilingualism might help to compensate for age-related deficits in certain cognitive processes.

With regard to the aspect of lexical processing, Gollan, Fennema-Notestine, Montoya and Jernigan (2007) found that naming difficulties of bilinguals remain into older age. However, compared to the advantages in executive control, the magnitude of bilingual deficits in lexical access does not seem to increase in older age. This was indeed confirmed by Bialystok et al. (2008), who found no interactions between age and bilingualism on any of their verbal tasks. Accordingly, they concluded that concerning lexical processing, bilinguals and monolinguals seem to undergo similar decline processes. Moreover, verbal fluency results by Rosselli et al. (2000) seem to corroborate the idea that bilinguals show improved or at least stable abilities of executive control in older age. Their finding that even
though older bilinguals performed worse on semantic fluency, they were not different from monolinguals on the phonological task indicates that their advantage of executive control still enables them to compensate for deficits in lexical access.

6.5. Research Questions

1 Are middle-aged and elderly bilinguals different in their verbal fluency performance when compared to age-matched monolinguals?

2 Are age-related effects in verbal fluency performance the same for bilinguals and monolinguals?

3 What insight does the analysis of phenomena such as clustering and switching give into the processes underlying verbal fluency performance?

4 Are there any differences between different age- and language groups regarding the occurrence of these phenomena?

6.6. Method

6.6.1. Participants

The participants in this study were 52 bilinguals and 52 monolinguals belonging to two different age groups. Participants in the younger age group were between 35 and 55 years old and participants in the older age group were between 65 and 85 years old. The 26 bilinguals in the younger age group had a mean age of 46.1 (SD= 5.7) and the 26 bilinguals
in the older group had a mean age of 73.2 (SD=6.2). All bilingual participants were speakers of Dutch and Frisian, had acquired their second language before the age of 7 and had used both languages on a daily basis since then. It is important to mention that the two languages of this bilingual group are typologically related and are very similar, for example, with regard to their lexicon and syntax. Consequently, many content words are the same in both languages. The monolinguals were selected to match the bilingual group with regard to age (M=48.1; SD=5.2 for the younger group and M=73.5; SD=4.1 for the older group) and level of education, as these were found to be influential factors on verbal fluency and therefore needed to be similar between the language groups. 50 monolinguals were speakers of German, and the remaining 2 monolinguals were speakers of English. The reason why native speakers of German were chosen for the monolingual group instead of native speakers of Dutch is that people in the Netherlands are exposed to foreign languages to a greater extent than people in most other countries, such as Germany. English is deeply embedded in Dutch society, which is reflected in the English proficiency level of most Dutch speakers.

As German and Dutch are very closely-related West Germanic languages and share many cognates and other linguistic features, German monolinguals seemed to be an appropriate control group for comparing bilinguals and monolinguals. What was more important for the purpose of this study was the condition that all bilinguals were bilingual in the same two languages, which was indeed the case (Dutch/Frisian). Apart from that, as all participants of the same language group (bilingual/monolingual) were from the same geographic area, within-group conditions (e.g. cultural, regional aspects) were highly comparable.
The bilingual data set used for this study had already been collected independently by one of the investigators (Author 2014). The bilingual participants were from the Dutch Province of Friesland in the North of the Netherlands. The monolingual participants were from the same geographical area in the North-West of Germany, which is an area without any obvious local dialects or non-standard varieties of German. All participants were in good mental and physical health and did not use any medication that might influence their processing speed or reaction ability.


6.6.2.1. Verbal Fluency Task.

All participants completed seven verbal fluency trials, i.e. four semantic trials and three phonological ones in order to ensure that verbal fluency performance was not only based on one single fluency trial per condition. The semantic fluency trials consisted of the categories: fruits + vegetables, jobs, musical instruments and water animals. The phonological fluency trials comprised the letters r, b, and j. As this study compares bilinguals and monolinguals with different native languages (Dutch/Frisian and German), a corpora comparison was conducted to ensure that these letter categories were equally large in those languages (see chapter 3). As Dutch and German are two closely related West-Germanic languages, they share many cognates, which makes fluency performance in these languages comparable (e.g. Dutch appel and German Apfel in semantic fluency). Another aspect that was controlled for was that both languages have the same sort of prefixes starting with the letters for phonological fluency. In both Dutch and German it is possible to form a large number of verbs by adding the prefix be- to words, e.g. Dutch: oordelen –
Because of their language relatedness, this is exactly the same in German: urteilen – beurteilen. Therefore, no language-specific advantages or disadvantages regarding a particular letter category were expected.

Participants were tested by two investigators who followed a strict script to ensure the same verbal instructions for all test sessions. Testing took place in the participants’ homes. The test language for the bilingual participants was Dutch and the monolingual participants were tested in German, which was the L1 of all monolingual speakers. For the semantic fluency task, people were asked to name as many words from a specific category and start producing words as soon as possible. For the phonological fluency trials, participants were asked to produce only words beginning with a particular letter. Furthermore, they were instructed not to name different forms of the same word, such as saying both buy and bought, to avoid proper names, names of places or numbers and not to create new words by simply adding words to a previously-produced word, e.g. first saying the word baseball and then say the word baseball cap. If this happened nevertheless, it was counted as a mistake and not included in the total word score. Apart from these limitations, participants were told that they were allowed to produce words from all categories, e.g. verbs, nouns, adjectives etc. All trials were recorded with a voice recorder and eventually transcribed.

6.6.2.2. Scoring.

For each of the seven individual fluency trials, the total number of generated words was counted. Repetitions and errors were not included in the total word count. Both for semantic and phonological fluency the numbers of words from the individual trials were added up as total scores to enable generalizing over the two conditions.
6.6.2.3. Clustering.

Regarding the coding of clusters and switches, the applied method was mainly based both on that of Troyer et al. (1997) and that of Abwender et al. (2001). Similar to what Troyer et al. (1997) did, definitions of semantic clusters for the three semantic categories were created emergently, while analyzing the data. Semantic clusters were defined as sequences of at least two adjacent words belonging to the defined categories. For *fruits*+*vegetables*, these were for example *citrus fruits, berries* or *types of cabbage*. For *water animals* emerging subcategories were, for example *reptiles* or *amphibians*. What was also coded as clusters were words that were strongly related words for reasons of common usage, e. g. *peas* and *carrots*, due to similar appearance such as *sharks* and *whales* or because of shared living environments, e.g. *penguins* and *polar bears*.

The coding of phonological clusters on the two phonological fluency trials was done exactly as defined by Troyer et al. (1997). Phonological clusters were two or more adjacent words that started with the same two letters, rhymed or were homonyms. For all analyses of clustering, repetitions and errors were included, the same way as in the study by Troyer et al. (1997), since these words nevertheless provide information about the course of lexical retrieval during the verbal fluency trials.

Based on these clusters, two different measures of clustering were analyzed: the mean cluster size and a new measure of clustering, which will be referred to as *cluster ratios*. For this measure, the total numbers of clustered words per condition were divided by the total number of words generated during that condition:
Cluster ratio_{\text{semantic fluency}} = \frac{\text{number of clustered words on semantic fluency}}{\text{total number of words on semantic fluency}}

The cluster ratio is a solid measurement of how much participants clustered during a verbal fluency trial, as it takes into account their overall performance. Regarding only the total number of produced clusters does not necessarily give insight into the cluster abilities of a participant, as a low number of clusters might merely be a consequence of low verbal fluency performance. Participants who produce only two clusters with a small mean cluster size can still have a cluster ratio of 100%, which implies that although they produced relatively few words, all of these words were part of a cluster.

6.6.2.4. Switching.

To measure the amount of switching during verbal fluency trials, this study uses Abwender et al.’s (2001) distinction between hard switches and cluster switches. Switches between clustered words and non-clustered words or switches only between two non-clustered words were coded as hard switches. Switches between clusters on the other hand were coded as cluster switches. As measurements of switching behaviour, we again made use of ratios. The total number of hard switches and cluster switches were added up for the two fluency conditions (semantic and phonological) and divided by the total number of words produced per condition, resulting in relative measures which we call hard switch ratio and cluster switch ratio.
6.6.2.5. Inter-rater reliability.

All verbal fluency trials from all participants were coded for number of clusters, mean cluster size, and the numbers of cluster switches and hard switches by two independent raters who were both sufficiently proficient in Dutch and German. The inter-rater reliability was calculated with Cronbach’s $\alpha$ resulting in $\alpha > 0.8$ (good internal consistency) for semantic fluency and $\alpha > 0.9$ (excellent internal consistency) for phonological fluency. In case of discrepancies between ratings, averages were used for the analyses.

6.7. Results


A MANCOVA with level of education as covariate showed no main effect of language group for the total number of words produced on semantic fluency, meaning that on average bilinguals produced as many words on semantic fluency as monolinguals. However, there was a main effect of age-group. In both language groups, the younger participants (M=76.1, SD=15.1) produced significantly more words on semantic fluency than the older participants

(M=66.2, SD=13.7), $F(1,99)=19.5$, $p<0.01$, $\eta^2=0.15$ (medium effect size).
6.7.2. Semantic fluency – Clustering & Switching.

A MANCOVA controlling for level of education showed that monolinguals had a significantly higher hard switch ratio as compared to the bilingual participants (table 1). The bilingual group on the other hand outperformed the monolinguals both in terms of semantic cluster ratio and mean semantic cluster size.

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<tr>
<th>Component</th>
<th>bilinguales</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>F(1,99)</th>
<th>p</th>
<th>η²</th>
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<td>Hard switch ratio</td>
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<td>0.14</td>
<td>0.48</td>
<td>0.1</td>
<td>9.9</td>
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<td>0.08</td>
</tr>
<tr>
<td>Cluster ratio</td>
<td></td>
<td>0.69</td>
<td>0.12</td>
<td>0.63</td>
<td>0.1</td>
<td>8.1</td>
<td>&lt;0.01</td>
<td>0.07</td>
</tr>
<tr>
<td>Mean cluster size</td>
<td></td>
<td>2.79</td>
<td>0.45</td>
<td>2.54</td>
<td>0.29</td>
<td>11.2</td>
<td>&lt;0.01</td>
<td>0.1</td>
</tr>
</tbody>
</table>

With regard to the effects of age-group on semantic clustering and switching, the analyses showed (table 2) that whereas the younger participants have significantly higher hard switch ratios, the older participants outperform the younger participants in terms of semantic cluster ratio and mean cluster size. These age effects are the same for both language groups.
Table 2: Significant effects of age-group on semantic fluency

<table>
<thead>
<tr>
<th>Componen t</th>
<th>middle-aged</th>
<th>elderly</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Hard switch ratio</td>
<td>0.48</td>
<td>0.12</td>
</tr>
<tr>
<td>Cluster ratio</td>
<td>0.63</td>
<td>0.11</td>
</tr>
<tr>
<td>Mean cluster size</td>
<td>2.59</td>
<td>0.36</td>
</tr>
</tbody>
</table>

In order to investigate to what extent the different components of semantic fluency are related to the overall performance on this condition, correlations were run between each component and the total number of words. As all clustering and switching measures consist of ratios and not of absolute values, potential correlations can provide valid information about which of the components are important for higher overall performance. Results show that whereas both semantic cluster ratio and mean cluster size are positively correlated with overall performance, hard switch ratios are negatively correlated with the total number of words. There was no significant correlation between cluster switch ratios and overall performance on semantic fluency.
Table 3: Correlations between components of semantic verbal fluency and total number of words

<table>
<thead>
<tr>
<th></th>
<th>total # of words</th>
<th>semantic fluency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson’s $r$</td>
<td>p-value</td>
</tr>
<tr>
<td>Hard switch ratio</td>
<td>-0.481</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cluster ratio</td>
<td>0.536</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Mean cluster size</td>
<td>0.464</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

6.7.3. Phonological fluency – Overall performance.

For overall performance on phonological fluency, a MANCOVA controlling for level of education showed a significant interaction between language group and age-group (F(1,99)=5.3, p<0.05, $\eta^2=0.04$). Whereas the older monolingual group produced significantly fewer words (M=30.6, SD=8.3) compared to the younger monolinguals (M=38.5, SD=8.2), there was no such age effect for the bilingual participants. The older bilinguals performed equally well on phonological fluency as the younger bilinguals (see figure 1). Consequently, there was only a significant difference between bilingual and monolingual performance on phonological fluency for the older participants. The older bilinguals (M=40, SD=10.4) produced significantly more words than the monolinguals in that age group (M=30.6, SD=8.3) F(1,99)=9.8, p<0.01, $\eta^2=0.07$. This was different for the younger participants where there was no significant difference between the bilinguals and the monolinguals.
6.7.4. Phonological fluency – Clustering & Switching.

There were no significant differences between bilinguals and monolinguals regarding clustering and switching on phonological fluency. However, there was a trend that the bilingual participants have higher cluster ratios than the monolinguals (p=0.086). This trend turned out to be significant for the performance on the B-trial, where bilinguals had significantly higher cluster ratios (M=0.5, SD=0.2) than the monolinguals (M=0.41, SD=0.2), F(1,99)=4.32; p<0.05, η²=0.04. With regard to the effects of age, it turned out that older participants of both language groups produced higher phonological cluster ratios (M=0.49, SD=0.17) than the younger participants of both groups (M=0.42, SD=0.14), F(1,99)=4.86; p<0.05, η²=0.05. Regarding correlations between clustering and switching on phonological fluency, the components of cluster switch ratio, cluster ratio and mean cluster size were positively correlated with overall performance. These correlations are weaker.
than for semantic fluency. For phonological fluency, there was no significant correlation between hard switch ratio and total number of words.

Table 4: Correlations between components of phonological verbal fluency and total number of words

<table>
<thead>
<tr>
<th></th>
<th>total # of words</th>
<th>phonological fluency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pearson’s $r$</td>
<td>p-value</td>
</tr>
<tr>
<td>Cluster switch ratio</td>
<td>0.3</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cluster ratio</td>
<td>0.2</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Mean cluster size</td>
<td>0.3</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

6.8. Discussion

Contrary to previous research (Gollan et al. 2002; Portocarrero et al. 2007; Sandoval et al. 2010), the results of our study do not show any evidence for a bilingual disadvantage on the verbal fluency task. On semantic fluency, both the middle-aged and elderly bilinguals produce as many words as their monolingual controls. Regarding age-related effects on semantic fluency, this study can confirm a general age-related decline in semantic verbal fluency performance (Troyer 2000; Acevedo et al. 2000). In both language groups, the elderly participants produce fewer words than the middle-aged participants. The fact that this effect is the same for bilinguals and monolinguals can confirm the hypothesis that the decline in lexical access in older age might not be stronger for bilingual speakers (Gollan,
Fennema-Notestine, Montoya & Jernigan 2007). The equal performance of middle-aged bilingual and monolingual speakers on phonological fluency is in line with previous research which did not find lower performance of bilinguals on this condition, either (Rosselli et al. 2000; Portocarrero et al. 2007). The finding that the elderly bilinguals in our sample outperform the elderly monolinguals indicates that the bilinguals might be less affected by age-related decline on phonological fluency. Interestingly, phonological fluency is the condition which is said to be more related to strategic search processes and executive function (Portocarrero et al. 2007; Sauzéon et al. 2011). Consequently, the better performance of the elderly bilingual group on this task might be caused by enhanced abilities of executive function in this group, as similarly reported by other research (Bialystok et al. 2006). The absence of this effect within the middle-aged bilingual group could be explained by evidence from previous research also suggesting that bilingual cognitive benefits are stronger for older than for younger bilinguals (Bialystok et al. 2006).

Taking into account potential explanations for a bilingual disadvantage in lexical access as discussed by Sandoval et al. (2010), the absence of such a disadvantage in this study might be explained by sample-specific characteristics. First of all, as mentioned before, the two languages of our bilingual group are typologically-related and share many lexical items. With regard to the between-language-interference account this would imply that our bilinguals should be less affected by language interference. If a word is the same in both languages, there can hardly be any interference from the non-target language while that word is being produced in the target-language. The same is true for the ‘weaker-links’ account, which explains slower bilingual lexical access by lower frequency-in-use of lexical items for bilinguals. If a word is simply the same in the two languages of a bilingual, it is not to be expected that this particular word is activated less frequently by a bilingual than
by a monolingual speaker. Therefore, the Frisian/Dutch bilinguals in this study would not be expected to have slower lexical access caused by frequency-in-use effects. Apart from that, the test language Dutch is the majority language of the bilingual speakers’ environment and the bilingual group was highly proficient in that language. Both of these aspects make it less likely that the bilinguals should have a smaller vocabulary in Dutch than monolinguals in their one language. Thus, the bilingual speakers in this group were probably not slowed down in their lexical access by a smaller vocabulary in the target language. The fact that the bilingual group in this study produced more words in semantic clusters and larger clusters than the monolinguals implies that they do not have any deficits related to vocabulary size or activation of lexical items within a semantic field. However, as the processes of clustering and switching are related to each other – higher cluster ratios usually mean lower hard switch ratios – group differences do not necessarily mean that, for example, the monolingual group is less capable of forming clusters or the bilinguals less good at switching to unrelated words. The differences between the bilingual and monolingual data in our group merely reflect different use of these processes.

On semantic fluency, the older participants in both language groups made more use of clustering than switching to words from different subcategories. This might be further evidence for the idea that age-related decline in semantic verbal fluency is more related to decline in cognitive flexibility or controlled processing rather than to deficits in lexical access, for example while activating semantically related words (Troyer et al. 1997). Regarding phonological fluency, the trend that bilinguals have higher cluster ratios on this condition might be evidence for more strategic and controlled retrieval among this group.
6.9. Conclusion.

Our study compared the verbal fluency performance of middle-aged and elderly Frisian/Dutch bilinguals to that of German monolinguals. We wanted to find out whether there are any differences in lexical access between these groups and what happens to verbal fluency performance in bilingual aging. Furthermore, we included the analyses of different processes during verbal fluency, namely the occurrence and amount of clustering and switching. The purpose of this was to examine whether these additional analyses could help to gain more insight into the underlying processes of bilingual lexical access in older age. First of all, this study does not suggest lower bilingual performance on the verbal fluency task. Both age groups in our study performed equally well or even better than the monolingual control group. These findings support the idea that bilingual verbal fluency data can lead to diverging results and that not all studies can report a bilingual disadvantage in lexical access. It is likely that a bilingual deficit in lexical access simply does not occur in particular bilingual groups and that this is related to sample-specific characteristics. On the one hand, differences in bilingual lexical access might be related to language-specific differences. Different language combinations vary in terms of the number of cognates, identical words, frequency of words etc., which will inevitably affect the magnitude of cross-language interference. On the other hand it is also possible that differences in language use (e.g. language proficiency, language dominance) between several bilingual groups lead to differences in lexical access, which might have caused inconsistent results between studies. Certain language combinations (e.g. the typologically-related languages Frisian and Dutch) are less likely to be affected by phenomena such as between-language interference. Additionally, there will also be less difference between bilinguals and monolinguals in the frequency of use of these common words, and in the vocabulary size of
each of their languages. It might be helpful to focus on these language-specific and speaker-specific differences in more detail when analyzing bilingual verbal fluency. Apart from that, the analysis of sub-processes of verbal fluency such as clustering and switching provided useful insight into different effects of bilingualism and aging on verbal fluency performance. Future research might benefit from this approach, especially in cases where bilinguals are significantly different from monolinguals in their verbal fluency performance. That way, it could be easier to pinpoint the exact processes of lexical access that might be affected in bilingual speakers and lead to group differences on the verbal fluency task.