AGE-OF-ACQUISITION RATINGS FOR 2816 DUTCH FOUR- AND FIVE-LETTER NOUNS

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Studies on object and word naming have shown that the age at which words are acquired is an important factor in processing times. Research on the issue in Dutch has been hampered by the fact that only teacher ratings were available about which words should be known by 6-year-olds. As a supplement to these teacher ratings, we conducted a large-scale study in which 556 students rated the age-of-acquisition of 2816 four- and five-letter nouns. Reliability of the ratings is high, and correlations with word frequency and word regularity are in the same order as those reported for English.

Virtually all psycholinguistic researchers agree that word frequency (i.e., the number of times a person is likely to come across a particular word) is an essential variable in word processing. High frequency words are easier to process than low frequency words. This is true for all sorts of word processing tasks (e.g., word naming, lexical decision, perceptual identification) and no model of word recognition has a chance of being accepted in the literature if it does not account for the frequency effect (for a review, see Mousell, 1991). Also, experiments on the effects of other variables in word processing are unlikely to be published if word frequency has not been taken into account. As a result, researchers have invested major efforts to collect frequency norms for their language. In Dutch, for a long time the frequency norms of Uit den Bosch (1975) were used. These were based on a corpus of 720,000 written words. Nowadays, the Uit den Bosch corpus has been replaced by the electronic Cellex Database (Bazyle, Piepenbrock, & Van Rijn, 1993), which is based on a corpus of 42,380,000 written words. Similarly, in English the old Kucera and Francis (1967) measures are currently being replaced by the Cobuild frequencies from the Cellex Database. These frequency measures have their limitations (e.g., they are nearly all based on written corpora; and there are always choices to be made about which texts to include, which types of word derivatives to combine in the frequency measures, etc.), but in general it is thought that the

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existing measures are reliable enough for practical purposes (at least in Dutch and English) and that further gains would not outweigh the efforts needed to collect additional data.

During the last five years or so, evidence is rapidly growing that the robust frequency effects in word processing tasks are actually a compound of two variables: the frequency with which words are encountered in texts (i.e., the usual or impression of the word frequency effect), and the age at which the words have been acquired by individuals. Although it is true that most high frequency words have been acquired early in life and most low frequency words have been acquired later in life, giving rise to a strong positive correlation between word frequency and word age-of-acquisition (see below), there are exceptions (e.g., in English puppy is a low frequency word that is known by infants, whereas income is a high frequency word that is unlikely to be known by children). Using such words, Morris and Ellis (1995) were able to disentangle the effects of word frequency and word age-of-acquisition (AoA), and they presented evidence that at least part of the usual frequency effect in word naming and lexical decision is due to AoA. These results have been replicated by Gerhard and Barry (1998, 1999a) and Turner, Valentine and Ellis (1998) for English by Yamazaki, Ellis, Morrison, and Lambon-Ralph (1997) for Japanese, and by Brysbaert (1996) and Brysbaert, Lange, and Van Wijntendael (2000b) for Dutch. Inspired by these findings, authors have started to examine AoA effects in other tasks. The importance of word AoA in addition to word frequency had already been suggested a long time ago for picture naming (Carroll & White, 1973), and new experiments with better-controlled materials have indeed established that a large proportion of the variability in picture naming latencies is due to the age at which the object names have been acquired. This is not only true for English (Barry, Morris, & Ellis, 1997; Ellis & Morrison, 1998), but also for Spanish (Cuetos, Ellis, & Alvarez, 1999) and French (Alario & Ferrand, 1999). Using a speeded naming task in which participants were instructed to name as many words as possible, they found that the speed effect of AoA was stronger than in a normal naming task. Investigating the importance of AoA in the semantic system, van Loon-Verswoon (1999) and Brysbaert, Van Wijntendael, and De Deye (in press) reported significant AoA effects in a word association task in which participants were asked to announce the first associate that came to their mind when they saw a stimulus word. Brysbaert et al. additionally reported an effect in a task in which participants had to decide whether a word belonged to the category of nouns with a definable meaning or to the category of first name. Finally, Lewis (1999) reported independent effects of frequency and AoA in a face categorization task. In this task, participants had to indicate to which TV-soap pictures of characters

belonged. The variables that were manipulated were the time since the first appearance in the soap (AoA) and the average exposure time during an episode (frequency). Both variables had an effect.

Other research has indicated that AoA is unlikely to be a confound of a third variable. For instance, both Brysbaert, Lange, and Van Wijntendael (2000) and Coltheart, Laxon, and Kening (1988) showed that the AoA effect in visual word processing is not due to the imagability of the words. Although AoA and imagability are intercorrelated (see below), the effect of AoA on word naming and lexical decision remained significant when stimulus lists were matched on both word frequency and word imagability.

Glyshellinck and Brysbaert (submitted) examined the correlations between word familiarity, word frequency, and word AoA in an attempt to solve a long-lasting debate in the literature on word recognition. In 1984, Gerhard showed that the subjective measure of word familiarity (based on the question: "how often have you come across this word?") explained significantly more variance in word processing times than word frequency. Ever since, there has been a debate about what exactly word familiarity measures in addition to word frequency (see e.g., Balota, 1994). Glyshellinck and Brysbaert’s series of experiments strongly suggest that the missing variable is AoA, as the variance in word processing times explained by word familiarity equals the variance explained by word frequency plus the variance explained by word AoA.

Finally, there are theoretical reasons to expect AoA as a crucial variable in word processing in addition to word frequency. Lewis (1999), for instance, pointed out that AoA and frequency are two different measures of how often a person has encountered a particular word. The amount of experience with a word that has been acquired early in life will on average be greater than the amount of experience with a word that has been acquired only recently. According to Lewis, it may very well be that not only the recent experiences with a word counts, but the cumulative frequency of all encounters with a particular stimulus (which would be evidence for an instance-based organization of the mental lexicon). This line of reasoning agrees with Glyshellinck and Brysbaert’s finding of the relationship between word familiarity, word frequency, and word AoA. On the basis of simulations with connectionist network models, Ellis, and Lambon Ralph (in press) reported that the effect of AoA is likely to go beyond mere cumulative frequency. They argued that words learned first by a network have a privileged status in the network because they can be implemented in all possible units and connections between units, and because early training makes for larger weight changes than later learning. The activation function in a typical connectionist network follows a sigmoid curve with small changes towards the extremes and large changes in the middle of the curve.
Due to this characteristic, words that are frequently used will tend to stay in the short-term memory, whereas words that are less frequently used will tend to be forgotten more quickly. This phenomenon is known as the 'frequency effect' in the study of language and cognition.

A different approach to measuring frequency is through the use of semantic networks. These networks represent the relationships between words and concepts, and can be used to measure the frequency of word use.

Different Aka Measures

A list of Aka language measures is shown in the following table, along with their respective units of measurement:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Units of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word frequency</td>
<td>Times per minute</td>
</tr>
<tr>
<td>Semantic network frequency</td>
<td>Times per hour</td>
</tr>
<tr>
<td>Visual modality</td>
<td>Percent correct</td>
</tr>
</tbody>
</table>

A final thought on the relationship between Aka language and cognitive development is that more frequent use of words is likely to lead to better cognitive performance, as evidenced by higher scores on cognitive tests.

Finally, it is worth noting that the relationship between Aka language and cognitive development is not a linear one, and that other factors, such as the child's age and prior educational experience, can also play a role. However, the evidence suggests that early exposure to Aka language can have a positive impact on cognitive development in Aka-speaking children.
of 13 or more (see Gilhooly & Logie, 1980). This resulted, for example, in a score of 1.80 for apple. The correlation between both AoA measures was 0.75. In addition, further research showed that both measures had virtually the same correlation with object naming times (Ellis & Morrison, 1998). On the basis of these and other studies (e.g., Gilhooly & Gilhooly, 1980; Lyon, Teer, & Rubenstein, 1978), Morrison et al. (1997) concluded that student ratings are a valid measure of AoA (see also De Moor et al., 2000). Therefore, most work on AoA effects in English has relied on the student ratings published by Gilhooly and Logie (1980). These authors asked 36 students to rate the AoA of different words on the 7-point scale described above. To assess the reliability of their ratings, Gilhooly and Logie divided the participants randomly in two groups, balanced for sex, and found an intergroup correlation of .98.

The studies done in Dutch so far all made use of a different AoA measure. In 1981, Kohorst, Schaarlaeckens, de Vries, Akkerhuis, and Fronoinkx published a book that indicated for 6,785 words to what extent each word should be known by 6-year-olds (see also Schaarlaeckens, Kohorst, & Lejáncrégí, 1999, for a very recent update of the list). The estimates were obtained by asking a representative sample of teachers from the Netherlands and the Dutch speaking part of Belgium to mark for each word whether it should be known by a 6-year-old or not. For the Belgian data, 40 teachers of kindergarten and 41 teachers of the first year of primary school from all over the Dutch-speaking region took part in the assessment. The advantages of the Kohorst et al. measure, defined as the percentage of teachers indicating that a word should be known by a pupil who starts primary school, are that the measure is based on persons who have daily experience with the children they are judging, and that the measure has been obtained some 20 years ago (when the undergraduates of current studies were born). In addition, van Loon-Vervoorn (1989) obtained a correlation of .92 between the Kohorst et al. measure and student ratings on an 8-point scale, based on 44 nouns. The Kohorst et al. ratings have proven very useful in several studies, but they are limited because they only provide information about one moment in time: the transition from kindergarten to primary school. There is no information about whether a word that is known by a 6-year-old, has been acquired at the age of 2 or at the age of 5; similarly, a word that is not known at the age of 6 according to the teacher ratings, can be acquired at the age of 7 or at the age of 15 and later. Also, the different measures used in English and in Dutch studies make it difficult to interpret deviating findings between both languages. Therefore, we decided to collect student ratings of AoA for the Dutch language as well.

**DUTCH AGE-OF-ACQUISITION NORMS**

**Method**

**Stimulus Materials and Rating Procedure**

We selected 2816 four- and five-letter nouns from the CELEX Database (Baayen et al., 1993). The selection was limited to four- and five-letter nouns for practical reasons and because we typically use words of these lengths in our studies of visual word processing. Nouns were chosen partly because they can be used in picture naming experiments. Words with a frequent non-noun interpretation and nouns with multiple frequent meanings or with a frequency less than 1 per 42,380,000 were excluded. Of the stimulus set, we created 10 lists of 281 or 282 words that were matched on frequency and word length. Because our previous experience had shown that rating scales like Gilhooly and Logie’s (1980) were sometimes confusing for the participants, we simply asked them to indicate for each word from which age they estimated they knew the word. If they did not know the word, they could write an “N”. Of each list, three different permutations were made to minimise sequence effects. The lists were handed out at the beginning of a course, and completion of a list took about half an hour. Each participant completed but one list.

**Participants**

Participants were 558 undergraduates (310 females and 248 males). They were students from the faculties Political and Social Sciences, Criminal Sciences, Philosophy or Moral Sciences at Ghent University. All were native Dutch speakers. Average age was 19 (range 16-42).

**Results and Discussion**

The AoA data are shown in the Appendix. The full matrix of AoA, frequency, Log(frequency) and % of answers is available on the internet http://filturner.rug.ac.be/~laurensen/vakgroep/ (Research, available documents, data, etc.).

For each list we computed the correlation between the individual ratings and the mean AoA measures. Sixteen participants who correlated less than .68 with the means were excluded from further analyses. All in all, the minimal number of raters per list was 50. To assess the reliability of our ratings, we calculated the intraclass correlation of Shrout and Fleiss (1979). For this analysis, words that were not known by at least 80% of the
participants were excluded and the missing AoA values for the remaining words were estimated on the basis of the means of the rows and the columns. The reliability of the individual lists varied from .95 to .98, and the reliability of the total stimulus set was .98.

To further check the reliability and validity of our AoA measure, we computed the correlation between our figures and the figures that had been collected by Lange1 in 1995. She asked 43 psychology students from the University of Leuven to indicate for 180 four- and five-letter words at which age they thought they had acquired them, using Gilhooly and Logie's (1980) rating scale. Reliability of Lange's AoA ratings was .96. Figure 1 shows the correlation between our measure and hers for the 121 words in common. The correlation amounted to .90, which is nearly the maximum that can be obtained, given the measure reliabilities of .98 and .96. This analysis shows that (1) the student ratings are stable over time and over geographical location, and (2) that the rating scale we used, returns the same data as Gilhooly and Logie's.

Figure 2 shows the correlation between Log(frequency) and AoA ($r = .95$). The reported correlation coefficients between frequency and rated AoA in English range from -.40 (Rubin, 1980) to -.71 (Gilhooly & Logie, 1982).

We also correlated the teacher ratings of Kohsntamm et al. (1981) with our AoA ratings. This correlation of $-.80$ ($N = 756$; see Figure 3) shows that the Kohsntamm et al. (1981) measures are indeed a good alternative for student ratings, as already suggested by van Loon-Verboom (1989, see above) and our own previous work with the Kohsntamm et al. measure (Brysbaert, 1996; Brysbaert et al., 2000; Brysbaert et al., in press).

van Loon-Verboom (1985) had all the words of the Kohsntamm et al. (1981) list rated on a 7-point scale for imagability. Thus we could also correlate our AoA ratings with this imagability measure (Figure 4). The correlation we obtained was rather low: $r = .38$ ($N = 756$). This is very similar to the correlation of .38 reported by Morrison et al. (1997), but unlike the correlation of .72 reported by Gilhooly and Logie (1980).

Finally, we compared our AoA ratings with the English measures for words that could be considered as unequivocal translations (e.g., slang-nuker). The correlation with Morrison et al.'s (1997) AoA measure based on individual tests with children was .60 ($N = 113$), the correlation with Gilhooly and Logie's (1980) student ratings was .71 ($N = 377$). These correlations show that AoA measures in different languages converge, as one could expect from the multiple interactions between the English and the Dutch cultures.

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1 Personal communication, May 19, 1999.
Conclusion

It is becoming increasingly clear that researchers who want to investigate frequency effects have to control their stimulus materials for AoA. In addition, the AoA effect is becoming an interesting issue on its own. Although individual researchers will always be frustrated by the shortage of measures and by the fact that we could not obtain more objective measures (but see De Moor et al., 2000), we hope that the present data will provide Dutch speaking researchers with the same means as their English colleagues to start to clarify these issues.

References


DUTCH AGE-OF-ACQUISITION NORMS


