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Objective age-of-acquisition (AoA) norms for a set of 230 object names in French: Relationships with psycholinguistic variables, the English data from Morrison et al. (1997), and naming latencies

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Picture naming speed is strongly influenced by the age of acquisition (AoA) of words. Most studies of AoA have relied on adults' AoA ratings. However, objective AoA has been found to be a stronger determinant of picture naming latencies. Whereas objective AoA norms for words have been collected for some language communities, no objective AoA measures for words were previously available in French. The study provides objective AoA norms for a set of 230 object names following the procedures used by Morrison, Chappell, and Ellis (1997) to collect objective AoA measures in English. The relationships between objective AoA measures, rated AoA, other variables used in psycholinguistic experiments (name agreement, image agreement, conceptual familiarity, etc.), the English data collected by Morrison et al., and naming latencies are analysed and discussed. In addition, reanalyses of data on picture naming latencies (Bonin, Chalard, Méot, & Fayol, 2002) with the use of objective AoA norms are provided. Stepwise multiple analyses show that objective AoA is a stronger determinant of (spoken and written) naming latencies than rated AoA, whereas objective word frequency is not a reliable independent determinant and does not interact reliably with AoA in any of the analyses.

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Factors influencing picture naming speed have been systematically explored in an attempt to delineate the processes and the representations that are involved in this task. Several picture and word attributes that influence naming speed have been identified. More precisely, the degree of agreement among participants about the name used to refer to a picture (i.e., name agreement; Barry, Morrison, & Ellis, 1997; Bonin et al., 2002; Lachman, Shaffer, & Hennrikus, 1974; Vitkovitch & Tyrrell, 1995), the degree of agreement between the visual appearence of a picture and the mental image corresponding to the underlying depicted concept (i.e., image agreement; Barry et al., 1997; Bonin et al., 2002), the number of different mental images generated from a picture name (i.e., image variability; Bonin et al., 2002), the familiarity of the concept depicted by a picture (Snodgrass & Yuditsky, 1996), and the number of details in a picture (i.e., visual complexity; Ellis & Morrison, 1998) are among the main determinants of naming speed. However, among the determinants of naming speed, it is word frequency and word age of acquisition (AoA) that have commanded the most attention.

Since Oldfield and Wingfield's (1964, 1965) pioneering studies, word frequency effects have been found to be robust in picture naming and many researchers have considered that objective word frequency plays a crucial role in accessing lexical representations (Humphreys, Riddoch, & Quinlan, 1988; Jescheniak & Levelt, 1994; Lachman, 1973; Lachman et al., 1974; La Heij, Puerta-Melguizo, van Oostrum, & Starrevelt, 1999; Oldfield & Wingfield, 1964, 1965). Word frequency effects have also been observed in other word processing tasks such as word naming (Connine, Mullenix, Shernoff, & Yelen, 1990; Forster & Chambers, 1973; Frederiksen & Kroll, 1976; Grainger, 1990; Hino & Lupker, 2000; Hudson & Bergman, 1985; Monsell, Doyle, & Haggard, 1989; Strain, Patterson, & Seidenberg, 1995) and lexical decision (Bonin, Chalard, Méot, & Fayol, 2001a; Brysbaert, Lange, & Van Wijnendaele, 2000; Gerhand & Barry, 1999b; Morrison & Ellis, 1995; Turner, Valentine, & Ellis, 1998). Word frequency effects, however, have been the subject of much discussion. One strongly made claim is that word frequency effects are actually AoA effects (Morrison, Ellis, & Quinlan, 1992). In effect, word frequency and AoA are correlated (as far as French is concerned, Alario & Ferrand, 1999, have reported a significant correlation of $-.367$) in such a way that early acquired words tends to be more frequent than those acquired later. A number of studies have therefore tried to isolate the effects of these two variables. When both word frequency and AoA are taken into account, strong AoA effects have been observed in picture naming (Bonin, Fayol, & Chalard, 2001b; Bonin et al., 2002; Carroll & White, 1973b; Ellis & Morrison, 1998; Gilhooly & Gilhooly, 1979; Morrison et al., 1992; Morrison, Hirsh, Chappell, & Ellis, 2002; Vitkovitch & Tyrrell, 1995), word naming (Brown & Watson, 1987; Coltheart, Laxon, & Keating, 1988; Gilhooly & Logie, 1981; Morrison & Ellis, 1995; Morrison et al., 2002; Yamada, Takashima, & Yamazaki, 1998; Yamazaki, Ellis, Morrison, & Lambon Ralph, 1997), and

lexical decision (Brysbaert et al., 2000; Gerhand & Barry, 1999b; Morrison & Ellis, 1995; Turner et al., 1998), whereas reliable word frequency effects have been found in some studies (Barry et al., 1997; Bonin et al., 2001a; Brysbaert, 1996; Brysbaert et al., 2000; Ellis & Morrison, 1998; Gerhand & Barry, 1998; Gerhand & Barry, 1999a, b; Lachman, 1973; Lachman et al., 1974; Morrison & Ellis, 2000; Snodgrass & Yuditsky, 1996; Turner et al., 1998), but not in others (e.g., Bonin et al., 2002; Bonin, Fayol, & Chalard, 2001b; Carroll & White, 1973b; Morrison et al., 1992). As far as picture naming is concerned, some studies have found an independent contribution of both variables or an interaction between the two variables (e.g., Barry et al., 1997; Ellis & Morrison, 1998), whereas some more recent picture naming studies have found reliable AoA effects when word frequency was controlled for whereas no reliable word frequency effect has been found when AoA was controlled for (Barry, Hirsh, Johnston, & Williams, 2001; Bonin et al., 2001b). Using a large set of words and multiple regression analyses, Bonin et al. (2002) found a strong and reliable contribution of rated AoA on both spoken and written picture naming latencies but did not find that word frequency made an independent, reliable contribution or interacted with AoA. The clear challenge for future research is thus to determine to what extent, and under what conditions, these two variables affect word processing if we are to gain a better understanding of the loci and the mechanisms that give rise to these effects. The problem is somewhat complicated by the fact that most studies that have investigated word frequency have not taken AoA into account. Although many researchers have stressed the importance of considering both word frequency and AoA (Ellis & Lambon Ralph, 2000), word frequency is still investigated in some studies without any consideration of AoA (e.g., Hino & Lupker, 2000; La Heij et al., 1999).

Most studies that have investigated AoA have made use of *rated* AoA norms obtained from adults, probably because they are easier to collect than objective AoA norms. Rated AoA norms for words have been published for different languages (e.g., Alario & Ferrand, 1999, for French; Ghyselinck, De Moor, & Brysbaert, 2000, for Dutch; Morrison et al., 1997, for British English; Pind, Jonsdottir, Tryggvadottir, & Jonsson, 2000, for Icelandic). To collect rated AoA scores, adults are asked to estimate the age at which they think they have learned each of the words in a list using point scales that correspond to various age bands. As far as French is concerned, Alario and Ferrand (1999) asked adults to estimate the age at which they thought they had learned each of the words in its oral *or* written form. A 5-point scale was used with 3-year age bands in between, with 1 = learnt at 0–3 years and 5 = learnt after 12 years. Other norming studies have used more sensitive scales: 7 points with 2-year age bands in between (Barry et al., 1997; Gilhooly & Hay, 1977; Gilhooly & Logie, 1980; Morrison et al., 1997; Pind et al., 2000), 8 points with 2-year age bands (Carroll & White, 1973b) or 9 points with 1-year age bands between 2 and 6 years and 2-year age bands above (Carroll & White, 1973a; Lyons, Teer, & Rubenstein, 1978; Rubin, 1980).

Two questions have been raised concerning rated AoA scores: (1) Are rated AoA scores reliable? (2) Are rated AoA scores valid? Studies that have dealt with either or both issues have generally yielded a consistent picture. Rated AoA scores are both reliable and valid, as we shall now briefly review.

THE RELIABILITY OF RATED AOA NORMS

Two methods have been used in order to assess the reliability of AoA ratings. The first one consists in computing a correlation between two sub-groups of items. For instance, in their French normative study, Alario and Ferrand (1999) repeated 17 words in the list and found a correlation of .94. With the use of this method, strong correlations have been reported (from .81 to . 98) (e.g., Gilhooly & Logie, 1980; Jorm, 1991; Walley & Metsala, 1992). The second method consists in determining the correlation between two similar samples that have been estimated by different participants in different studies. For example, Morrison et al. (1997) compared their AoA ratings with those of Gilhooly and Logie (1980) using a sample of 94 items and found a correlation of .85. This method has been frequently used to assess the reliability of rated AoA and it has generally yielded high correlations (from .73 to .97) (e.g., Cirrin, 1984; Gilhooly & Logie, 1980; Jorm, 1991; Pind et al., 2000; Snodgrass & Yuditsky, 1996). The reliability of rated AoA scores is now well established. The finding that rated AoA scores are reliable strongly suggests that adults rely on the same kind of information when assigning AoA values to words. However, a crucial issue has been to determine whether AoA ratings are valid, that is to say whether they truly reflect the age at which words are learned.

THE VALIDITY OF AOA RATINGS

Estimated AoA measures are performance variables, that is to say a behavioural outcome and not an intrinsic property of the words in the same way as word frequency (Zevin & Seidenberg, 2002), which may be thought of as being influenced by various factors related to words such as objective word frequency, imageability, concreteness, and so on. It might therefore be objected that rated AoA measures do not truly reflect the age at which words are learned but some combination of variables with which they are correlated. Indeed, correlational studies have shown that early acquired words tend to be more frequent (Alario & Ferrand, 1999; Barry et al., 1997; Morrison et al., 1997; Pind et al., 2000), shorter (Barry et al., 1997; Morrison et al., 1997; Pind et al., 2000), more imageable (Gilhooly & Hay, 1977; Morrison et al., 1997), more concrete (Gilhooly & Hay, 1977) and more familiar (Alario & Ferrand, 1999; Barry et al., 1997; Brown & Watson, 1987; Gilhooly & Hay, 1977; Morrison et al., 1997; Pind et al., 2000) than later acquired words. Therefore, we cannot exclude the possibility that adults' AoA ratings are influenced by these dimensions (with adults referring to some kind of ''metalinguistic knowledge'' to assign AoA

scores to words; see Jorm, 1991; Nickels & Howard, 1995; Walley & Metsala, 1992, for more details on this issue). It is not surprising therefore that one important issue has been to ensure that AoA ratings are valid measures of the actual age at which words are learned. Among the studies that have addressed this issue, Gilhooly and Gilhooly's (1980) is certainly one of the most important. In their first experiment, their participants had to rate the age at which they thought they had learnt 53 words that were presented in a list. Rank order of acquisition for each of these words was available in the Mill Hill standardised vocabulary test. Using a simultaneous regression analysis that included two measures (log transformed) of word frequency (frequency measures from Thorndike & Lorge, 1944, and from Kucera & Francis, 1967, respectively), word length and rated AoA, they found that rated AoA was the unique determinant of the Mill Hill rank order of acquisition. In their second experiment, 48 words for which AoA ratings were available from the Gilhooly and Hay (1977) database were presented to children and to young adults of varying ages (from 5 to 21 years old) as a vocabulary test. Again a simultaneous regression analysis indicated that among the following variables—the frequency measures from the Thorndike–Lorge (1944) and from the Kucera–Francis (1967) database, respectively, and five measures provided by Gilhooly and Hay (1977), i.e., imagery, concreteness, familiarity, meaningfulness, and rated AoA—only rated AoA significantly predicted the age at which a word is known in the vocabulary test. De Moor, Ghyselinck, and Brysbaert (2000) asked 6-year-old children to spell out the meaning of some 200 words and found that rated AoA was by far the most important determinant of the percentage of children who could do so. Other methods have been employed to assess the validity of AoA ratings (Carroll & White, 1973b; Jorm 1991; Lyons et al., 1978; Morrison et al., 1997; Pind et al., 2000) and have yielded similar findings. It should be noted, however, that recent studies have reported smaller correlations between rated and objective AoA measures than those that were initially reported by Carroll and White (1973b) and Gilhooly and Gilhooly (1980). Therefore, the pioneering studies on the rated AoA validity issue have probably overestimated the correlation of rated AoA with objective AoA (Pind et al., 2000). The implication, then, is that objective AoA scores should be employed when they are available (Morrison et al., 1997; Pind et al., 2000), even though AoA ratings are adequate substitutes when objective AoA norms are not available for some words.

Due to the composite nature of rated AoA, a necessary step has been to use objective AoA measures in AoA studies in the place of rated AoA in order to avoid incorrect conclusions. In effect, as claimed by Morrison and Ellis (1995), if a variable makes it possible to explain RTs in a particular task, it must be ensured that it is this variable which affects the task and not a correlated variable. Morrison et al. (1997) therefore collected objective AoA scores from children in order to determine that AoA effects are real and not due to certain confounded variables such as word frequency, familiarity and/or word length. In

their norming study, Morrison et al. (1997) asked 280 children, aged from 2 years and 6 months to 10 years and 11 months, to name 297 pictures of simple objects. According to these authors, this procedure has the advantage of ensuring that children possess semantic information about the pictures that they name correctly. Morrison and colleagues went on to show that objective AoA was a stronger predictor of word processing speed than rated AoA (Ellis & Morrison, 1998; Morrison & Ellis, 2000; Morrison et al., 2002).

THE PRESENT STUDY

As far as French is concerned, rated AoA scores from adults were recently provided by Alario and Ferrand (1999) for a set of 400 object names taken from the Cycowicz, Friedman, Rothstein, and Snodgrass (1997) English database. These ratings have already been used to conduct picture naming and lexical decision experiments (Bonin et al., 2001a, 2001b; 2002).

As far as we are aware, objective AoA norms for words are not available in French. The aim of our study was therefore to provide objective French AoA measures that we think will be very useful for research on AoA. To collect the norms, we chose to closely follow Morrison et al.'s (1997) procedures. The words for which we chose to collect objective AoA scores were the French labels corresponding to 230 of Snodgrass and Vanderwart's (1980) pictures. These pictures and their names have recently been standardised in French on several variables (among of these are rated AoA; see the Results and Discussion section for a description of these variables) by Alario and Ferrand (1999).

The present article is organised into two parts. The first part corresponds to the presentation of the collection of objective AoA norms and several analyses that have been performed on the basis of objective AoA, and thus can be considered as a simple extension of Morrison et al.'s (1997) work in English. However, some comparisons are made between our objective norms in French and those collected by Morrison et al. (1997) in English. More precisely, (1) Alario and Ferrand's (1999) rated AoA measures have been compared with objective AoA measures; (2) the pattern of correlations between rated AoA measures and other variables used in psycholinguistic experiments, and for which norms are available in the French corpus (these variables are described in the Results and Discussion section), has been compared with the pattern of correlations with objective AoA measures and the same variables; (3) multiple stepwise regression analyses have been performed in order to determine the essential determinants of both rated and objective AoA measures using these measures as dependent variables; (4) multiple stepwise regression analyses were performed with rated AoA as the dependent variable and objective AoA measures (in addition to the other variables) as the independent variable; and (5) the French AoA (rated and objective) measures have been compared with the English AoA measures from Morrison et al. (1997). The second part presents

some new analyses concerning naming latencies using the collected objective AoA norms. First, the spoken and written picture naming data from Bonin et al.'s study (2002), in which strong effects of *rated* AoA were found, have been reanalysed using objective AoA measures in order to test whether these effects are real and not due to some confounded variable correlated with rated AoA. To anticipate the results, the analyses have shown that objective AoA is a far stronger predictor of naming latencies than rated AoA norms. Second, more in-depth analyses are reported that have been performed in order to determine whether *objective word frequency* effects can also be captured when objective AoA norms are taken into account given that both the Bonin et al. (2001b) and Bonin et al. (2002) studies failed to find reliable word frequency effects on naming latencies when *rated AoA norms* were taken into account.

Method

Participants. 280 children attending school were involved in the normative study. 200 children came from Bourges and the remaining 80 children from Saint-Etienne. From 2 years 6 months to 7 years 11 months, an age band corresponded to six months whereas from 8 years to 10 years 11 months an age band corresponded to 12 months. There were 20 children in each age band.

Summary information about the children in each of the age bands is shown in Table 1. In addition, 23 psychology students at Blaise Pascal University formed the adult group. The participants were all native speakers of French and none of them was bilingual.

Stimuli. The pictures were taken from the Snodgrass and Vanderwart (1980) database. From the pool of pictures, two were not included because they are culturally unfamiliar for French speakers and only those having a single name in French were selected. Thus, 21 pictures having a modal name consisting of several words (e.g., ''*pince-à-linge*'', [*clothes-peg*]) were excluded. The modal names corresponding to the pictures were taken from the French standardisation of the Snodgrass and Vanderwart pictures performed by Alario and Ferrand (1999). In addition, a picture was retained for inclusion in the normative study only when it had a modal name which was provided by at least 50% of the participants, i.e., the percentage of name-agreement. This criterion was not fulfilled for seven pictures. Name agreement scores were taken from Alario and Ferrand. Overall, 230 pictures were selected for testing (see Appendix).

Procedure. The procedure was very similar to that used by Morrison et al. (1997) to collect the naming data. Each child was tested individually in a quiet corner of the classroom. The children were presented with the pictures each of which they had to name. They were told that they might not know the name of, or not recognise, some of the pictures. Whenever a child gave a name different

TABLE 1
Summary data on children tested for the objective age-of-acquisition norms

Age band (months)	*Mean age (months)*	*Number of females*	*Number of males*
30–35	33	12	8
36–41	40	11	9
42–47	44	14	6
48–53	52	9	11
54–59	57	7	13
60–65	62	11	9
66–71	69	9	11
72–77	76	12	8
78–83	82	10	10
84–89	88	11	9
90–95	93	9	11
96–107	102	10	10
108–119	114	10	10
120–131	126	9	11

from the expected one or did not come up with a name after a delay of 5 s, the experimenter cued her/him with the initial phoneme of the target name. Therefore, four types of responses that could be provided by the children were recorded: (1) The intended name was given in the first naming attempt; (2) A name different from the expected one was given, for instance ''*animal*'' was produced as the name for a picture of a *cat*. In the latter case, a phonemic cue was provided and, then, two responses could occur; (3) Either the intended name was then provided or (4) the intended name was still not produced. The responses that were given by each child and for each picture were carefully recorded by the experimenter. As far as childish mispronunciations are concerned, the rules used by Morrison et al. (1997) to score the responses were adopted. A response was scored as correct for a target length of one to three phonemes when only one phoneme was erroneously pronounced. For longer targets, i.e., four or more phonemes in length, the response was scored as correct in cases where only two phonemes were erroneously pronounced. Children aged from 2:6 to 7:11 were tested in three separate sessions during which approximately 80 pictures were presented. The three sessions for each child were conducted over a period of no more than 3 weeks. Three sets of 80 pictures were prepared for each test session with the constraint that the semantic categories to which the pictures related were distributed over the three sets. During a testing session, the pictures were pseudorandomly presented with the constraint that three consecutive occurrences of pictures belonging to the same semantic category were not allowed. Each session lasted for about 20 minutes.

For the remaining three age bands, 8:0 to 10:11, and for the adult group, the 230 pictures were presented in a single session.

RESULTS AND DISCUSSION

Assigning objective AoA values to words

Objective AoA scores were assigned to the labels corresponding to the pictures that were named by the children with or without a phonemic cue. Following Morrison et al. (1997), two procedures were used to assign objective AoA scores for the items. The first procedure was the 75% rule: The AoA assigned to a given word is the age which corresponds to the first age band where 75% of the children give the correct name for the picture. The second procedure was the curve-fitting procedure: A logistic regression was used to fit the log probability of correct naming as a function of age. More precisely, the objective AoA value of a given word was obtained by computing the age at which this probability was $p = .50$. These two procedures are described in more detail later. The objective AoA values for words obtained with the use of these two procedures are provided in the Appendix. They are also available on the Internet at the following URL: http://www.psy.univ-bpclermont.fr/~pbonin/pbonin-eng.html

Assigning objective AoA values using the 75% rule

The 75% rule consists in assigning words the AoA scores that correspond to the first age band in which at least 75% of the children give the correct name for the pictures. In order to avoid excessively low estimations due to sampling variations, an additional constraint is that the mean percentage of correct naming across the two subsequent age bands is 75% or above. More precisely, an age band was retained to derive the AoA of any given word whenever the two following conditions held: (1) At least 75% of the children gave the correct name in this age band and (2) the mean percentage of correct naming over the two next age bands was also at least 75%. The precise AoA value assigned to a word was the mid-point of the age band expressed in months. For instance, a picture named correctly by at least 75% of the children in the 78–83 age band and by at least 75% (on average) of the children in the 84–89 and 90–95 age bands was assigned an objective AoA value of 80.5 months. Therefore, the word that is used to refer to the picture is considered to be acquired at 80.5 months.

Three problems have occurred in connection with the use of the 75% rule. First, for some items, name agreement[1] (which refers to the degree to which participants agree on the name of the picture) in adults was below 75%. Therefore, no AoA value was assigned to these items (a dash is used in place of

[1] Name agreement scores were computed from the adult naming data, i.e., with or without phonemic cueing.

the objective AoA score in the Appendix). Second, some items reached the 75% criterion even in the very youngest age band. Although it does not seem inappropriate to apply the 75% rule for items that were just above 75% in this age band, applying the 75% rule is certainly too conservative for the items that were considerably above 75% (e.g., 100%). Morrison et al. (1997) chose to extrapolate the AoA values for this type of item by making use of a database (LEX) in which AoA norms were made available for children aged 8–16 months or 17–30 months based on parents' reports. Parents were presented with word lists from which they had to report whether or not their child knew the words in terms of both comprehension and production. However, the disadvantage of such a procedure is that objective word AoA values are pooled together with estimated AoA values. Also, to our knowledge, normative data on AoA from parents' reports are not available for French. For these reasons, we chose to strictly apply the 75% rule even for items that were clearly above the 75% criterion. Third, for an age band to be chosen as the AoA value of a given item, it was necessary for the mean percentage of correct naming over the two next age bands to be at least 75%. Therefore, no estimation was strictly possible using the 75% rule for the two oldest age bands. Consequently, two additional rules were adopted for these two oldest age bands in order to derive objective AoA scores: (1) An item was assigned to the last but one age band when it was named correctly by at least 75% of the children in this band and the average percentage of correct naming across the oldest age band and adults was also 75% or above; (2) when name agreement in both adults and the children in the oldest age band was at least 75%, the items were assigned an AoA score of 140.5. This arbitrary value corresponds to the mid-point of the 11:6–11:11 age band, which is the second 6-month interval above the oldest one. It was chosen in order (1) to avoid excessively ''optimistic'' objective AoA values that may occur as a consequence of sampling variability and also (2) to take account of the fact that the words belonged to the adults' vocabulary.

When this set of rules was applied, 34 items could not be assigned an objective AoA value (as indicated by a dash in the Appendix): The percentage of correct naming in adults was below 75% for 16 items (*balle*, *céleri*, *chemisier*, *chou*, *cor*, *frigidaire*, *gilet*, *grange*, *haie*, *moufette*, *pêche*, *poignée*, *poupée*, *revolver*, *sacoche*, *télévision*) and, for the remaining items, they failed to meet the criteria defined earlier (*aiguille*, *artichaut*, *asperge*, *bouilloire*, *cendrier*, *cheveux*, *commode*, *cuisinière*, *écrou*, *harpe*, *homard*, *lime*, *nuage*, *orteil*, *pastèque*, *poivron*, *salière*, *voilier*).

Assigning objective AoA values using the curve-fitting procedure

Univariate logistic regression involves fitting the log odds of success (here: correct naming) as a linear function of an independent variable (in the present case, age). This procedure has the advantage over the 75% rule that it allows

some statistical extrapolation to be performed for words acquired earlier or later than the observed age limits.

In order to compute the objective AoA values for words, the data were organised into two columns for each item. For each child, the first column contained the value 1 whenever correct naming occurred and the value 0 if naming was incorrect; the second column contained the age of the child expressed in months. Separate logistic regressions were then performed for each item. By inverting the linear relation, estimated regression coefficients were then used to derive objective AoA scores for a given probability of correct naming, which was set, as in Morrison et al. (1997), to $p = .50$.

We decided to limit the possible estimated values to between 18 months for the earliest acquired words and 140.5 months for the latest acquired words. In effect, in the former case, only a few words are produced by children below 18 months (Bassano, 2000) and, in the latter case, 140.5 months was the upper limit that permitted the use of the 75% rule. Twenty-six items fell below the 18 months limit (*avion*, *botte*, *chaise*, *chapeau*, *chat*, *chaussure*, *cheval*, *chien*, *couteau*, *crayon*, *cuillère*, *étoile*, *fleur*, *fourchette*, *lapin*, *lunettes*, *main*, *maison*, *moto*, *pantalon*, *parapluie*, *pied*, *poisson*, *pomme*, *table*, *voiture*). By taking into account the following three facts: (1) These words are learned very early in life; (2) at least 85% of the youngest children named them correctly and the 75% criterion was easily attained; and (3) earliest accepted estimations were 18 months for other items, we decided to assign an AoA value of 18 months to these items (a ''*'' is used in the Appendix to indicate these items). Eight items fell above the upper age limit (*bouilloire*, *céleri*, *chemisier*, *frigidaire*, *grange*, *haie*, *moufette*, *sacoche*) and were not assigned objective AoA scores (as indicated by a dash in the Appendix).

Reliability of the French objective AoA measures

As pointed out in the introductory paragraphs, a number of studies have shown that rated AoA norms are reliable. In order to determine whether the objective AoA norms we collected are reliable, we randomly selected two sub-samples comprising 10 participants for each child age band and 11 and 12 participants for the adult group. The same procedures as described previously were used to determine objective AoA in these sub-samples. As shown in Table 2, all of the correlations were high (nearly .90) indicating that the collected objective AoA norms are reliable.[2]

[2] In each of the sub-samples, the same elimination rules as those used for the entire sample were applied. Six additional items (*cacahuète*, *cintre*, *clou*, *interrupteur*, *paon*, *veste*) did not meet the criteria and were eliminated.

TABLE 2
Correlations among the different AoA measures from the two sub-samples

	LR-1	*LR-2*	*75-1*	*75-2*
LR-1		.968	.922	.891
LR-2			.911	.931
75-1				.902

LR = logistic regression, 75 = the 75% rule. 1 = first sub-sample, 2 = second sub-sample.

Comparison of objective and rated AoA measures

As we mentioned in the introductory paragraphs, psycholinguistic experiments have made widespread use of *rated* AoA scores because objective AoA scores for words are not always available in a given language and maybe also because the former are easier to collect than the latter. The comparison of rated AoA values with objective AoA scores is a necessary step in order to assess the validity of rated AoA. Although a number of studies have provided evidence that rated AoA is a valid measure of the age at which words are learned (Carroll & White, 1973b; Gilhooly & Gilhooly, 1980; Jorm, 1991; Lyons et al., 1978; Morrison et al., 1997; Pind et al., 2000), there has been no attempt, as far as French is concerned, to assess the validity of the rated AoA scores that are currently available in the literature, that is to say the estimated AoA scores from the Alario and Ferrand (1999) database.

Only items with a name agreement[3] score above 75% were included in the analyses (name agreement scores were taken from Alario and Ferrand's, 1999, database). Application of this criterion led us to discard 28 items (*aiguille*, *bouilloire*, *céleri*, *chameau*, *chemisier*, *chou*, *cochon*, *cor*, *cuisinière*, *écrou*, *feuille*, *frigidaire*, *gilet*, *grange*, *grenouille*, *horloge*, *moufette*, *orteil*, *pêche*, *phoque*, *poupée*, *revolver*, *sacoche*, *sauterelle*, *stylo*, *tonneau*, *train*, *voilier*). Overall, 201 items were included in the analysis performed with the curve-fitted technique and 186 items in the analysis performed with the 75% rule procedure.

[3] The name agreement scores used here were those taken from Alario and Ferrand (1999), and not those obtained from the adult naming data in the present study, since the procedure that these authors employed did not make use of a phonemic cue, as is traditionally the case when collecting name agreement scores. Moreover, the name agreement scores provided by Alario and Ferrand were part of a large corpus for French used in several experiments including those that have been reanalysed in the present study using objective AoA scores (Bonin et al., 2002).

Table 3 shows the correlations between the two objective measures of AoA and the rated AoA measures taken from Alario and Ferrand (1999).[4] As expected, the two objective AoA measures were highly correlated, which indicates that both procedures used to derive objective AoA values capture the same features. The correlations between the two objective measures of AoA and rated AoA values were also high and of comparable size, an observation which provides additional empirical support for the claim made earlier that rated AoA measures provide valid estimations of the actual age at which words are learned. The observation that the correlations between objective and rated AoA values were less strong than those between the two objective AoA values might be partly due to the rather coarse nature of the scale employed by Alario and Ferrand to collect AoA ratings (i.e., a 5-point scale with 3-year bands in between). However, the pattern of correlations suggests that rated AoA measures are more closely associated with other word and/or picture attributes than objective AoA measures *per se*. It is worthy of note that the size of the correlations between the objective and rated AoA measures is somewhat lower than those that have been reported by Morrison et al. (1997) in English.

Figure 1 depicts the relationship between objective AoA obtained by the logistic regression procedure and rated AoA. A strong linear relationship was observed. A linear regression analysis using objective AoA as the dependent variable and rated AoA as the independent variable revealed that six items were not well adjusted (*asperge*, *balle*, *cheveux*, *commode*, *nuage*, *salière:* The standardised residuals were above three). These items exhibited large adjusted values when the logistic equation was used and relatively low rated AoA scores in relation to these values. A more in-depth investigation of the relationship between the percentages of correct naming and the age bands for these items revealed (1) large fluctuations between age bands which tend to have a con-

TABLE 3
Correlations among the three measures of AoA

	Rated AoA	*Objective AoA (LR)*	*Objective AoA (75%)*
Rated AoA	1	0.687	0.650
Objective AoA (LR)		1	0.933
Objective AoA (75%)			1

AoA = age of acquisition, LR = logistic regression, 75% = the 75% rule, $p < .001$ for all correlations.

[4] Rated AoA values were obtained by means of a 5-point scale with 0–3 at one extreme and 12+ at the other and 3-year age bands in between. The rated AoA scores were not converted into months in the analyses.

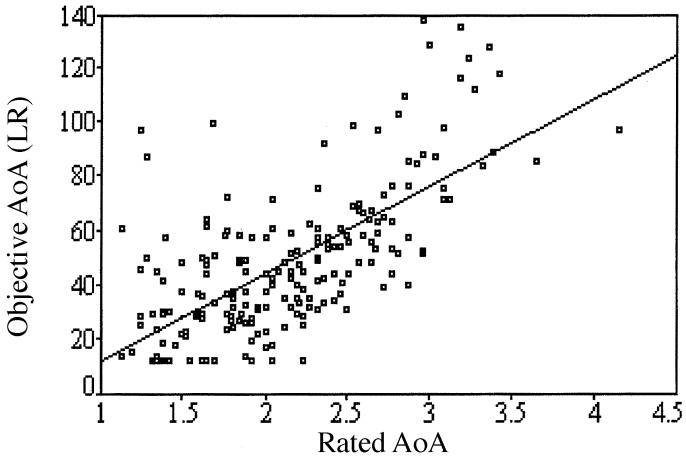

Figure 1. Scatterplot of the relationship between rated AoA and objective AoA obtained with logistic regressions. The equation of the regression line is: objective AoA = −17.13 + 31.04 rated AoA. R^2 = .467.

siderable effect on the estimations given by the logistic model (*balle*, *cheveux*, *commode*, *salière*); (2) and/or a low percentage agreement for all the age bands when compared with rated AoA (*asperge*, *commode*, *nuage*, *salière*). Given this sampling variability, we decided to remove these items from the subsequent analyses and to indicate their objective AoA values (curve fitted) with ''**'' in the Appendix. With these six items removed from the analyses, the correlation between objective AoA (curve fitted) and rated AoA values was .74.

Figure 2 shows the relationship between objective AoA with the 75% rule and rated AoA. A linear relationship was also observed, although it was less strong than the relationship found between the curve-fitted AoA and rated AoA. Indeed, there is a great variability in rated AoA for any given value of the objective AoA and estimated scores are under/over represented. Moreover, two kinds of outliers were found. First, words that received an objective AoA of 140.5 months were generally rated as acquired earlier. This was particularly true for the following items: *cacahuète*, *cintre*, *landau*, *paon*, and *veste* (the values of these items are followed by ''**'' in the Appendix). This latter observation confirms the idea that the arbitrary value that was retained for the last age band with the 75% rule was too conservative. It should nevertheless be recalled that it was chosen in order to avoid excessively optimistic objective AoA values. Second, the item ''*manteau*'' was estimated to be acquired relatively early in life, whereas its objective AoA value indicated that this word was actually acquired relatively late. When the relationship between the percentages of correct naming and the age bands was examined thoroughly, it appeared that this item suffered from very high sampling variability which did not allow it to reach

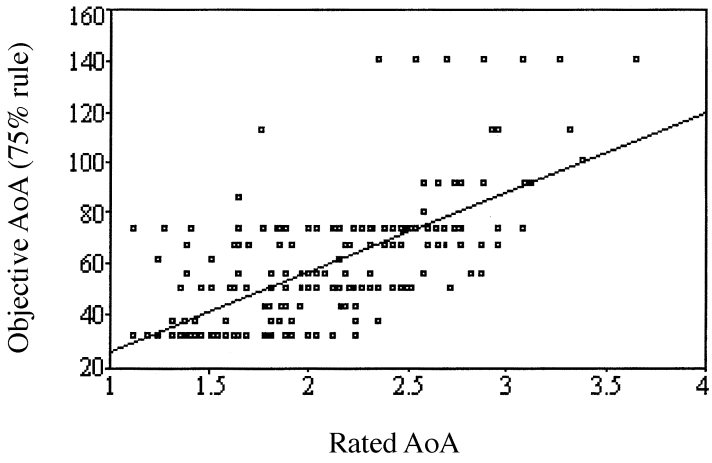

Figure 2. Scatterplot of the relationship between rated AoA and objective AoA obtained with the 75% rule. The equation of the regression line is: objective AoA = −5.08 + 31.3 rated AoA. R^2 = .423.

the 75% criterion before the last but one age band. With these six items removed from the analyses, the correlation between objective AoA (75% rule) and rated AoA values was .677, whereas the correlation between the two objective AoA measures was .935.

Apart from a small number of items for which there are some large discrepancies between objective and rated AoA measures, the relationships between objective and rated AoA measures are strong. Therefore, as it has often been claimed, these results clearly establish that AoA ratings are valid estimates of the age at which words are actually acquired. The AoA ratings provided by Alario and Ferrand (1999) can thus be used as adequate substitutes for objective AoA scores.

Relationships between the three AoA measures and other variables used in psycholinguistic experiments

Rated AoA has been considered as a composite variable that embodies elements of word frequency, conceptual familiarity, imageability, and so on (e.g., Morrison et al., 1997; Paivio, Clark, Digdon, & Bons, 1989). Since several psycholinguistic experiments have included these variables together with rated AoA in an attempt to determine their contribution to predicting RTs in word production (e.g., Barry et al., 1997; Bonin et al., 2002; Snodgrass & Yuditsky, 1996), it is important to investigate whether the relationships that have been found with these variables and rated AoA are of the same nature as the relationships between those variables and objective AoA measures.

Five variables taken from the Alario and Ferrand (1999) database were considered: name agreement (NA), image agreement (IA), conceptual familiarity (Fam), visual complexity (VC), and image variability (Ivar). We also considered two measures of objective word frequency: Brulex written word frequencies (Bf; Content, Mousty, & Radeau, 1990) and more up-to-date written word frequencies, referred to as Frantext (Ff), as given by the LEXIQUE database (New, Pallier, Ferrand, & Matos, 2001).

As described earlier, *name agreement* refers to the degree to which participants agree on the name of the picture. It was measured by taking into account the number of alternative names given to a particular picture across participants. *Image agreement* refers to the degree (evaluated using a 5-point scale) to which mental images generated by participants in response to a picture match the picture's visual appearance: A rating of 1 indicates that the picture provides a poor match for the image and a rating of 5 indicates a very good match. *Familiarity* refers to the familiarity of the concept depicted. This was also measured on a 5-point scale (1 = a very unfamiliar object, 5 = a very familiar object). *Visual complexity* corresponds to the number of lines and details in the drawing. In the Alario and Ferrand (1999) norming study, the participants rated the complexity of each drawing on a 5-point scale (1 = drawing very simple, 5 = drawing very complex) rather than the complexity of the object it represented. *Image variability* was again rated on a 5-point scale. This measure indicates whether the name of an object evokes few or many different images for that particular object (1 = few images, 5 = many images). For this latter norming task, Alario and Ferrand presented the name of the pictures and not the pictures themselves. It should be noted that we used image variability instead of imageability (as in Morrison et al., 1997) because norms for this latter variable were not available for all the words used in our study. In addition, word length (number of phonemes) was included.

In the following analyses, word frequency values were transformed to log(x+1). Given the discrepancies that were noted in the preceding analyses when comparing the three AoA measures, items that were identified as outliers were discarded from the analyses. Consequently, 195 items remained when objective (curve-fitted) AoA measures were used and 180 items when objective AoA measures obtained from the 75% rule were used.

Table 4 shows the correlations between the three measures of AoA and the other eight variables. A high level of consistency in the correlations between the three AoA measures and the other eight variables was observed, especially when the signs of the correlations are taken into consideration. The pattern of correlations indicates that AoA has a composite nature. The correlations are particularly high with word frequency, image variability, familiarity, and name agreement. More frequent words and/or more familiar concepts tend to be acquired earlier in life than less frequent words and/or less familiar concepts (or the reverse given the correlational nature of the relation). Also, early acquired

TABLE 4
Correlations between rated and objective AoA with the other eight variables

	NA	*VC*	*Ivar*	*IA*	*Fam*	*Bf*	*Ff*	*Phons*
Rated AoA	−.208*	.223*	−.589*	.045	−.493*	−.508*	−.528*	.260*
Objective AoA (LR)	−.288*	.067	−.484*	−.059	−.267*	−.365*	−.359*	.100
Objective AoA (75%)	−.158*	.018	−.454*	−.030	−.273*	−.284*	−.277*	.042

AoA = age of acquisition, LR = logistic regression, 75% = the 75% rule, NA = name agreement, VC = visual complexity, Ivar = image variability, IA = image agreement, Fam = conceptual familiarity, Bf = Brulex frequency (Content et al., 1990), Ff = Frantext frequency (New et al., 2001), Phons = number of phonemes, * = $p < .05$.

words evoke more different mental images and have higher name agreement scores than late acquired words (or the reverse).

On the whole, rated AoA has higher correlations with the other eight variables than is the case when the two objective AoA measures are considered. This latter observation indicates that rated AoA measures are more heavily influenced by concepts and/or name attributes than objective AoA measures. This holds particularly true as far as familiarity, word frequency, visual complexity, and word length are concerned. It should also be noted that the objective AoA values obtained with the curve-fitting procedure are generally slightly more related to the other eight variables than when the 75% objective AoA measures are considered, especially as far as word frequency and name agreement are concerned.

Despite some differences in the size of the correlations, the pattern of correlations found in the current data is generally consistent with that reported by Morrison et al. (1997) in English. However, as far as visual complexity and word length (number of phonemes) are concerned, the correlations with the two objective AoA measures were higher (and significant) in Morrison et al.'s study than in the current one. Also, the correlations between their measures of AoA and familiarity were greater than those observed in the present study.

In order to compare the structures of the objective and rated measures of AoA, three stepwise multiple regression analyses were performed (note that simultaneous regression analyses yielded exactly the same patterns of results). The first and the second multiple regression analyses examined objective AoA using the curve-fitting technique and the 75% rule respectively as the dependent variables, while the third examined rated AoA as the dependent variable. The same set of independent variables was used in the three analyses: word length (number of phonemes), VC, Fam, NA, Ivar, Ff word frequency (log transformed).[5]

[5] These variables were selected in order to permit comparisons with Morrison et al.'s (1997) results. As already mentioned, image variability was used in the place of imageability because imageability values were not available for all the French words that were considered. Moreover, we report the results obtained with the use of the written frequencies (Ff) as given by LEXIQUE (New et al., 2001). However, the results were very similar when Brulex (Bf) frequencies were used.

Table 5 shows the results obtained in the three analyses. The two objective AoA measures were primarily influenced by Ivar, which indicates that words which evoke many different mental images are acquired earlier than words which evoke fewer different mental images (or the reverse). NA had a significant effect on the objective AoA obtained with the use of the curve-fitting procedure, with the result that high-NA for items tends to be associated with early acquired words.

Turning to rated AoA, all the variables except VC were found to make a significant contribution to the rated AoA scores. Thus, rated AoA scores appear to be more closely related to these variables than the objective AoA scores.

Compared with Morrison et al.'s (1997) results, the same pattern as that found for Ivar was also observed for imageability, which suggests that imageability and Ivar measures are related. The effect of NA was also significant for the curve-fitted objective AoA measures. However, there were also several differences: Fam and word length (phonemes) were significant for the three AoA measures in Morrison et al.'s study, whereas in ours, these variables were only significant for the rated AoA values. Also, word frequency was significant for the objective AoA using the 75% rule, whereas it was not significant in the current data. Finally, contrary to our observations, NA did not significantly influence the rated AoA scores. The differences between the two studies may be attributable to sampling variabilities and to the number of items, which was

TABLE 5
Significant predictors in the multiple stepwise regression analyses as a function of the three AoA measures taken as dependent variables: Objective AoA (LR), objective AoA (75%), or rated AoA (taken from Alario & Ferrand, 1999)

Predictors	*Increment in* R^2	*Beta-weights*	*t*	*p*
1. Logistic regression				
Ivar	.224	−.444	−7.18	<.001
NA	.052	−.230	−3.71	<.001
2. 75% rule				
Ivar	.206	−.454	−6.80	<.001
3. Rated				
Ivar	.346	−.341	−4.78	<.001
Ff	.050	−.162	−2.25	<.05
NA	.020	−.166	−3.11	<.01
Fam	.020	−.196	−2.89	<.01
Phons	.020	.153	2.71	<.01

Ivar = image variability, Fam = conceptual familiarity, NA = name agreement, Phons = number of phonemes, Ff = Frantext frequency (New et al., 2001).

larger in Morrison et al.'s study than in ours. The only very questionable difference is related to conceptual familiarity, which had clear significant effects in Morrison et al.'s study, whereas these effects were far from being significant in the present data set. We might speculate that this difference is, in part, attributable to the fact that the concepts/objects were not as familiar to French children as they were to English children.

Objective AoA as the principal determinant of rated AoA

In order to assess whether subjective AoA measures are based on objective AoA scores, the following multiple regression analyses were performed with rated AoA taken as the dependent variable and the same independent variables as used in the preceding regression analyses with the addition of objective AoA scores as independent variables.

The results of these analyses are presented in Table 6. The most important result was that objective AoA variables were the major significant determinant of rated AoA: The pattern of results indicates that objective AoA is the essential dimension on which the rated AoA scores are based. Fam and word length also have significant effects but these are less sizeable, thus indicating that familiar concepts tend to be acquired earlier than less familiar ones and also that shorter words are acquired earlier than longer ones. In addition, image variability had a significant effect using the curve-fitted objective AoA, and frequency reached

TABLE 6
Significant predictors in the multiple stepwise regression analyses using objective AoA (LR) or objective AoA (75%) as the independent variable and rated AoA (taken from Alario & Ferrand, 1999) as the dependent variable

Predictors	*Increment in* R^2	*Beta-weights*	*t*	*p*
1. Logistic regression				
Obj. AoA	.546	.595	13.05	$<.001$
Fam	.115	$-.281$	-5.69	$<.001$
Phons	.026	.158	3.90	$<.001$
Ivar	.008	$-.121$	-2.23	$<.05$
2. 75% rule				
Obj. AoA	.458	.546	11.80	$<.001$
Fam	.157	$-.333$	-6.36	$<.001$
Phons	.038	.166	3.56	$<.001$
Ff	.009	$-.120$	-2.17	$<.05$

Ivar = image variability, Fam = conceptual familiarity, NA = name agreement, Phons = number of phonemes, Ff = Frantext frequency (New et al., 2001), Obj. AoA = objective age of acquisition scores.

significance when using the 75% rule. These effects are questionable, however, because they are not observed when a simultaneous multiple regression analysis is used (note that the other significant effects are still observed).

Comparisons of AoA measures in French and in English

As stressed by Sanfeliu and Fernandez (1996), normative data vary greatly between languages. It is thus necessary to collect specific norms for each language. However, it does not seem unreasonable to expect that there will be significant similarities when a common set of items is compared in different languages. In the following analyses, objective and rated AoA scores collected by Morrison et al. (1997) and those obtained in the present study are compared.

Table 7 shows the correlations between the AoA scores obtained in French and in English. The numbers of items from which these correlations were computed are also mentioned in the Table. The correlations were all significant, positive and high. It appeared that: (1) The highest correlation was between the two rated AoA measures, which suggests that such measures offer a relatively high level of reliability; (2) the correlations between the French objective AoA scores obtained using the logistic regression procedure and the two English objective estimates were a little lower than the earlier correlation; (3) the 75% rule procedure yielded correlations with the two English objective scores, which were of a size comparable to those obtained between objective and rated AoA scores considered in one language only (about .70); (4) the same was true for the correlations between French rated AoA and English objective scores; (5) the lowest correlations were found between English rated scores and French objective estimates.

These results obtained from a rather limited set of items show that there exists, on the whole, an equivalent order of acquisition of the words and their underlying concepts. It also seems that the use of objective AoA estimates obtained in a different language can provide the same level of validity as the use

TABLE 7
Correlations between the French objective and subjective AoA scores (taken from Alario & Ferrand, 1999) and the English AoA scores (from Morrison et al., 1997)

French/English	*Objective AoA (curve fitted)*		*Objective AoA (75% rule)*		*Rated AoA*	
Objective AoA (curve fitted)	.789*	(127)	.798*	(155)	.581*	(155)
Objective AoA (75% rule)	.689*	(120)	.715*	(148)	.536*	(148)
Rated AoA	.716*	(127)	.723*	(155)	.843*	(155)

AoA = age of acquisition, * = $p < .001$, rated AoA were not transformed in months.

of rated AoA scores obtained in the studied language (at least as far as French and English are concerned). The validity of using rated AoA scores obtained in a language other than the language involved in the study appears to be lower and is certainly questionable. This latter aspect emphasises the importance of obtaining specific estimations for each language.

Reanalyses of previously published data on the determinants of spoken and written picture naming latencies in French

A number of studies have determined the contribution of several variables in predicting naming speed in an attempt to shed light on the processes and representations that are involved in spoken or written word production. Among the variables that have been found to make a strong contribution to predicting naming speed is *rated AoA*. However, even though a large number of studies have shown that rated AoA is a valid indicator of the age at which words are learned (Carroll & White, 1973b; Gilhooly & Gilhooly, 1980; Jorm, 1991; Lyons et al., 1978; Morrison et al., 1997; Pind et al., 2000; and the present study), some suspicion about the validity of such ratings still exists. Indeed, due to the composite nature of rated AoA, it might be argued that the use of rated AoA tends to give rise to some confusion when the effects of other variables that are related to rated AoA on naming speed are also taken into account. As the preceding analyses have shown, objective AoA scores are less linked to word frequency and, also, in general, to other variables. Thus, considering objective AoA instead of rated AoA should permit us to get a clearer picture of the contribution of variables that have been found to play a role in predicting naming speed.

A reanalysis of the data that were initially collected by Bonin et al. (2002) was performed using objective AoA scores instead of rated AoA scores. In this study, participants were presented with pictures on a computer screen and asked to speak aloud or write down (on a graphic tablet) the corresponding names as quickly as possible. The dependent variable was the onset latency (in ms) measured from picture onset to the initialisation of the spoken or the written response. The independent variables that were investigated and included in the multiple regression analyses were the same as those previously described, that is to say Ivar, Fam, NA, IA, word length (phonemes), word frequency (Brulex written frequencies), VC, and rated AoA. In addition to these variables, word length defined in terms of number of letters was included in the analyses given its potential importance regarding the written picture naming task. Finally, image agreement and an interaction term formed by rated AoA and word frequency[6] were included.

[6] It should be noted that a first set of regressions did not include the interaction term. However, these analyses are not reported since they revealed a very similar pattern of results.

The findings from the Bonin et al. (2002) analyses were clear-cut. The set of variables that were found to have significant effects on both spoken and written naming latencies were rated AoA, IA, and Ivar. Also, NA had a significant effect in spoken picture naming and reached significance in a one-tailed test only in written picture naming.

The data have been reanalysed using the same variables as in the original study with objective AoA values included in the place of rated AoA values. However, for the sake of clarity, we present only the results from stepwise multiple regressions (note that simultaneous regression analyses gave exactly the same results for rated AoA except that with the objective scores using the 75% rule, familiarity did not reach significance in written picture naming). Combining the various selection rules used to determine objective AoA scores and the items that were included in the Bonin et al. (2002) study left 191 (188) items for rated AoA in the spoken (written) naming task, 187 (183) for the objective scores obtained by the curve-fitting procedure and 177 (172) for objective values calculated with the 75% rule.

Tables 8 and 9 show the results for spoken (Table 8) and written (Table 9) naming. As far as the analyses considering *rated* AoA scores are concerned,[7] the pattern of results was the same as that reported in Bonin et al.'s (2002) study and reported above. If we now turn to the analyses that used objective AoA values, one first important aspect of note is that the R^2 of the obtained equations was found to be greater than when rated AoA values were used. More precisely, the gains in the percentage of explained variance varied between .121 and .164. A second aspect of note is that objective AoA was the major determinant of the latencies in both spoken and written picture naming. It should be recalled that even when only rated AoA scores were used, AoA emerged as a major determinant of naming latencies but the use of objective AoA makes this point much more obvious (the increments in R^2 and the the beta-weights associated with objective AoA were nearly twice as high as those associated with rated AoA). As far as written picture naming is concerned, it might be argued that the objective norms as provided here may not be entirely suitable for predicting written naming latencies. In the reading literature, it has been suggested that AoA effects for the written and the spoken forms may have different loci (Yamazaki et al., 1997) because of the variability in the age at which words enter the children's spoken and written vocabulary. Indeed, if we assume an independent orthographic locus for AoA effects in written naming, one should observe that objective AoA of the *written* form of the words should predict the naming latencies better than the objective AoA of the spoken form as used here. Given that objective AoA

[7] Because items with NA lower than 75% are not used in the analyses with objective AoA, which was not the case in the analyses conducted by Bonin et al. (2002), the equation including rated AoA with this restriction is also presented.

TABLE 8
Significant predictors in the multiple stepwise regression analyses using naming latencies as the dependent variable and including an interaction term between AoA and (Brulex) word frequency in spoken picture naming

Predictors	*Increment in R^2*	*Beta-weights*	*t*	*p*
1. Logistic regression				
Obj. AoA	.454	.529	8.98	<.001
NA	.034	−.165	−3.19	<.01
IA	.024	−.205	−3.69	<.001
Ivar	.011	−.157	−2.13	<.05
2. 75% rule				
Obj. AoA	.512	.644	12.22	<.001
NA	.028	−.162	−3.20	<.01
Fam	.017	−.150	−2.86	<.01
IA	.014	−.121	−2.41	<.05
3. Rated				
AoA	.246	.308	4.36	<.001
NA	.066	−.207	−3.56	<.001
IA	.039	−.300	−4.81	<.001
Ivar	.054	−.312	−4.12	<.001

AoA = age of acquisition, NA = name agreement, IA = image agreement, Fam = conceptual familiarity, Ivar = image variability.

norms for the written forms of words are not available so far in French, this issue remains to be explored in future work.

The analyses have also revealed the following results: IA was also found to exert a large and significant effect in both spoken and written naming when the three kinds of AoA measures were used. The effect of NA was significant when the three AoA measures were used in spoken naming, whereas in written picture naming, it was significantly observed only when rated AoA measures were used. Ivar made a clear contribution in the two naming tasks with the use of rated AoA and with the curve-fitted objective AoA scores. Fam was significant in both tasks only with the 75% rule. No other significant effects were found. It is important to note that neither word frequency (Brulex) nor the interaction term formed by AoA and word frequency were significant. Given that the absence of a word frequency effect might be questionable in the light of some reports of word frequency effects in addition to AoA effects in certain picture naming studies (e.g., Barry et al., 1997; Ellis & Morrison, 1998), a number of additional detailed analyses were performed in order to shed light on this issue.

TABLE 9
Significant predictors in the multiple stepwise regression analyses using naming latencies as the dependent variable and including an interaction term between AoA and (Brulex) word frequency in written picture naming

Predictors	*Increment in R^2*	*Beta-weights*	*t*	*p*
1. Logistic regression				
Obj. AoA	.426	.539	8.81	<.001
IA	.052	−.304	−5.29	<.001
Ivar	.029	−.212	−3.27	<.01
2. 75% rule				
Obj. AoA	.460	.623	11.24	<.001
IA	.035	−.205	−3.81	<.001
Fam	.028	−.173	−3.12	<.01
3. Rated				
AoA	.239	.349	4.83	<.001
IA	.090	−.358	−5.59	<.001
Ivar	.040	−.247	−3.19	<.01
NA	.016	−.130	−2.18	<.05

AoA = age of acquisition, NA = name agreement, IA = image agreement, Fam = conceptual familiarity, Ivar = image variability.

In search of the lost ''word frequency effect'' in picture naming?

It has been claimed that recent studies that have included large sets of items and more recent word frequency measures have generally found word frequency effects in addition to AoA effects (Ellis & Lambon Ralph, 2000). The previously reported analyses failed to find an independent effect of word frequency or an interaction between AoA and word frequency. The number of items cannot be the source of the discrepancy between the studies that have found an independent contribution of word frequency (Ellis & Morrison, 1998) or an interaction between AoA and word frequency (Barry et al., 1997), because we used around 200 items in the analyses, Ellis and Morrison (1998) used 220 items and Barry et al. (1997) used 195 items. However, the previous analyses used Brulex word frequency measures, which are not up-to-date word frequency measures. Fortunately, since the publication of the Bonin et al. (2002) study, more up-to-date word frequency measures have been made available for the French language (New et al., 2001). More precisely, two different kinds of word frequency measures are available: the Frantext frequency measures and the FastSearch frequency measures. The former are based on a corpus of written texts from 1950 to 2000, whereas the latter are based on 15 million French web pages (see New et al., 2001, for details). Therefore, to examine specifically the independent

contribution of word frequency and AoA in both written and spoken naming, we performed several multiple regression analyses using these two kinds of recent word frequency measures (Frantext and FastSearch respectively) and either rated AoA norms or objective AoA (using either the 75% rule or the curve-fitting procedure). In addition, the same analyses were performed with the inclusion of the interaction term formed by AoA and word frequency. Overall, 18 simultaneous multiple regression analyses were performed (9 examining independent effects and 9 including the AoA × word frequency interaction term). The results were clear-cut: Neither the independent effect of word frequency nor the interaction between AoA and word frequency was significant in any of the analyses. Therefore, contrary to the claim that word frequency effects should be found when *large sets of items* and *better* word frequency measures are used (Ellis & Lambon Ralph, 2000), we did not find, *at least on the stimulus set used in our study*, that word frequency makes a reliable independent contribution or interact reliably with AoA in either spoken or written picture naming even though we used a large set of items and recent word frequency measures. It is worth stressing that virtually all the picture naming studies that have included AoA and word frequency have found AoA effects, whereas the reverse is not true. However, the present findings do not allow us to come to a decision concerning the debate relating word frequency and AoA effects in object naming since previous reports in English have found effects of both variables and also, using a new set of 299 pictures recently standardised for French, we found effects of AoA and objective word frequency (using recent frequency counts, i.e., Frantext; New et al., 2001) in spoken picture naming (Bonin, Peereman, Malardier, Méot, & Chalard, in press). Clearly, the identification of the conditions that lead to the observation of *both* word frequency and AoA effects in picture naming is an issue requiring further investigation.

In conclusion, the present study makes a useful contribution in extending to the large body of empirical evidence through the observation that rated AoA measures are valid indicators of the actual age at which words are learned. Therefore, it reliably confirms the fact that rated AoA scores can be used as adequate substitutes for objective AoA scores when they are not available for words. However, we have shown that objective AoA measures are less heavily influenced by word and/or concept attributes such as word frequency, conceptual familiarity, and word length (in phonemes), a finding which clearly lends further support to the claim made by Ellis and Morrison (1998) that objective AoA scores should be used in the place of rated AoA scores when available. The latter point is worth emphasising if we wish to determine the genuine independent contribution of AoA in word processing. Finally, the reanalyses of our previously published data on spoken and written picture naming (Bonin et al., 2002) have shown that objective AoA is a stronger determinant of naming latencies than rated AoA, a finding that clearly indicates that AoA effects are real and not merely a reflection of other variables that are embodied

in rated AoA. The set of objective AoA norms should be very useful for researchers investigating effects of AoA in word processing.

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APPENDIX

Alphabetical listing of the 230 words and their scores on objective AoA and other word or picture attributes (taken from Alario & Ferrand, 1999)

					Rated AoA		Name agreement		Image agreement		Conceptual familiarity		Visual complexity		Image variability		Frequency	
Item	*Intended name*	*English*	*Objective AoA (LR) (months)*	*Objective AoA (75%) (months)*	*M*	*SD*	*H*	*%*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Brulex*	*Frant*
1	Abeille	Bee	49.75	74.5	1.88	0.71	0.47	82	3.63	1.07	2.43	1.01	4.93	0.26	2.33	0.84	16.76	3.23
2	Accordéon	Accordion	71.81	74.5	3.08	0.89	0.00	100	3.53	0.73	1.63	0.81	4.86	0.35	2.17	0.59	4.33	3.03
3	Aigle	Eagle	65.27	74.5	2.73	1.00	0.54	86	3.67	1.09	1.50	0.73	4.34	0.55	2.53	0.86	11.35	9.00
4	Aiguille	Needle	92.57	—	2.52	0.71	0.80	71	4.90	0.31	2.70	1.12	1.55	0.69	2.53	0.73	21.90	16.16
5	Ampoule	Light bulb	59.19	68.5	2.69	0.84	0.00	100	4.53	0.86	3.70	0.75	2.93	0.65	2.30	0.84	7.31	7.10
6	Ananas	Pineapple	54.31	68.5	2.46	0.76	0.00	100	4.77	0.43	2.73	1.11	4.52	0.69	2.28	0.70	1.10	2.10
7	Ancre	Anchor	84.02	113.5	3.32	0.95	0.00	100	4.13	1.17	1.90	0.92	2.14	0.58	2.33	0.66	6.12	4.03
8	Âne	Donkey	45.70	56.5	2.08	0.80	0.00	100	4.20	0.81	2.07	0.87	3.59	0.78	2.33	0.80	22.67	10.84
9	Araignée	Spider	45.49	62.5	2.15	0.83	0.15	96	3.03	0.89	2.20	0.96	3.21	0.82	3.13	1.01	10.42	8.29
10	Arbre	Tree	30.56	38.5	1.38	0.57	0.15	96	3.37	0.96	4.60	0.67	4.31	0.71	4.50	0.79	206.00	64.61
11	Arrosoir	Watering can	41.97	56.5	2.31	0.97	0.00	96	4.00	0.79	2.27	1.17	2.72	0.65	2.43	0.84	1.40	1.52
12	Artichaut	Artichoke	87.39	—	3.04	1.00	0.23	89	4.23	0.86	2.13	1.11	3.59	0.87	1.97	0.41	1.44	0.77
13	Asperge	Asparagus	135.03**	—	3.19	0.85	0.16	93	3.40	0.93	2.37	1.19	3.24	0.87	1.93	0.45	1.61	3.84
14	Autruche	Ostrich	76.54	92.5	2.88	0.93	0.15	96	4.20	0.85	1.10	0.31	3.72	0.45	2.07	0.58	1.95	1.61
15	Avion	Airplane	18.00*	32.5	1.92	0.93	0.29	96	3.93	1.08	2.63	1.16	3.17	0.76	3.33	1.06	49.80	34.71
16	Bague	Ring	61.28	74.5	2.32	0.85	0.00	100	2.63	0.89	4.00	1.05	2.28	0.75	3.97	1.10	11.78	9.10
17	Balai	Broom	31.97	44.5	1.95	0.80	0.00	100	3.77	1.43	4.10	0.84	2.28	0.75	2.60	0.93	7.23	7.71
18	Balançoire	Swing	58.44	74.5	1.84	0.85	0.00	100	3.57	1.10	2.47	0.90	1.69	0.66	2.90	0.77	1.74	1.77
19	Balle	Ball	87.12**	—	1.27	0.45	0.00	100	2.57	0.82	2.87	0.97	2.45	0.91	3.07	1.05	38.00	31.81
20	Ballon	Balloon	23.30	32.5	1.35	0.49	0.40	89	1.23	0.77	2.50	0.90	1.52	0.78	3.47	1.07	12.55	17.82
21	Banane	Banana	28.41	38.5	1.58	0.70	0.00	100	4.60	0.67	3.87	0.94	1.21	0.41	2.23	0.68	2.68	2.45
22	Boîte	Box	64.36	86.5	1.65	0.75	0.26	89	2.70	1.49	2.97	1.03	1.21	0.62	3.87	1.14	53.05	58.77
23	Bol	Bowl	29.02	68.5	1.38	0.50	0.29	93	3.30	1.21	4.47	0.82	1.62	0.73	3.47	1.07	8.04	11.74
24	Botte	Boot	18.00*	32.5	2.04	0.77	0.40	89	2.47	1.04	3.73	1.01	2.69	0.76	3.07	1.11	21.39	5.55
25	Bougie	Candle	22.31	50.5	1.96	0.68	0.00	100	4.03	0.85	3.60	1.03	2.45	0.63	3.43	1.01	1.86	10.65
26	Bouilloire	Kettle	—	—	3.31	0.62	1.01	57	2.27	1.08	3.60	1.28	2.93	0.70	2.33	0.76	2.04	1.71
27	Bouteille	Bottle	27.56	32.5	1.92	0.80	0.00	100	4.00	0.95	4.20	0.81	1.83	0.80	4.17	0.87	40.67	38.29
28	Bouton	Button	48.50	68.5	1.85	0.78	0.00	100	4.80	0.48	4.43	0.90	2.03	0.63	3.77	1.19	29.31	15.19

29	Bras	Arm	49.15	62.5	1.50	0.71	0.15	96	4.07	1.01	4.93	0.25	2.28	0.65	2.90	1.24	346.00	290.29
30	Brosse	Brush	37.65	74.5	1.77	0.71	0.15	96	2.67	1.27	4.23	1.10	2.69	0.81	3.17	1.02	9.27	11.35
31	Bureau	Desk	56.12	68.5	2.65	0.85	0.00	100	3.20	0.81	4.60	0.93	2.97	0.73	3.67	0.88	105.00	97.77
32	Bus	Bus	52.85	68.5	2.19	0.80	0.34	89	4.00	1.02	4.03	1.00	3.76	1.09	3.17	0.87	0.00	7.16
33	Cacahuète	Peanut	91.92	*140.5***	2.35	0.85	0.00	100	3.87	1.38	2.60	0.89	2.59	0.82	2.20	0.71	1.06	0.39
34	Cadenas	Padlock	88.87	101.5	3.38	0.90	0.00	96	4.20	0.61	2.47	1.14	2.14	0.58	2.47	0.86	1.40	1.42
35	Camion	Truck	29.07	32.5	1.62	0.75	0.00	100	2.77	1.04	3.23	1.10	2.90	0.67	3.29	1.08	21.44	18.19
36	Canapé	Couch	32.17	44.5	2.16	0.90	0.34	89	3.17	1.02	4.40	0.89	2.31	0.81	3.27	1.14	8.93	10.03
37	Canard	Duck	26.71	38.5	1.85	0.92	0.29	93	3.47	0.68	2.50	0.94	2.97	0.73	2.83	0.91	12.97	9.58
38	Canon	Cannon	75.38	92.5	3.08	0.98	0.16	93	3.43	1.04	1.07	0.25	4.62	0.49	2.03	0.61	45.13	20.81
39	Carotte	Carrot	29.12	38.5	1.58	0.64	0.00	100	4.47	0.63	3.90	0.96	3.07	0.92	2.30	0.79	3.14	2.48
40	Casquette	Cap	36.01	50.5	2.27	0.78	0.29	96	1.80	0.85	2.57	1.07	2.28	0.75	3.07	0.83	14.84	18.16
41	Casserole	Pot	32.36	56.5	1.96	0.72	0.00	100	3.60	0.86	4.50	0.78	2.14	0.44	3.07	0.83	7.35	11.84
42	Ceinture	Belt	45.04	74.5	2.42	0.70	0.41	86	4.23	0.77	4.13	1.07	1.93	0.65	2.87	0.90	24.84	20.87
43	Céleri	Celery	—	—	3.46	1.03	0.65	61	1.80	1.27	2.00	1.14	4.66	0.61	1.87	0.68	0.63	0.90
44	Cendrier	Ashtray	108.75	—	2.85	0.92	0.16	93	3.30	1.12	4.00	1.23	2.62	0.82	3.30	1.21	2.72	5.87
45	Cerf	Deer	57.52	68.5	2.88	1.14	0.29	93	3.80	0.96	1.87	1.07	3.66	0.72	2.20	0.66	3.82	13.13
46	Cerise	Cherry	57.99	74.5	2.00	0.80	0.29	93	3.77	1.19	3.13	1.14	1.34	0.61	2.73	1.01	7.01	2.48
47	Chaîne	Chain	63.13	74.5	2.69	0.84	0.67	79	2.93	1.66	2.93	1.39	2.72	1.03	3.17	1.15	44.50	45.71
48	Chaise	Chair	18.00*	32.5	1.38	0.64	0.00	100	3.13	0.97	4.93	0.25	2.24	0.74	3.43	1.14	81.68	48.45
49	Chameau	Camel	50.29	68.5	2.62	0.90	0.68	50	2.70	1.51	1.20	0.48	3.86	0.79	2.17	0.70	9.01	3.52
50	Champignon	Mushroom	34.01	38.5	2.35	1.06	0.00	100	3.67	0.99	2.90	0.88	3.00	0.65	3.57	1.07	6.42	4.16
51	Chapeau	Hat	18.00*	32.5	1.62	0.70	0.00	100	2.93	1.01	2.83	1.23	2.38	0.56	4.00	0.98	87.21	42.48
52	Chat	Cat	18.00*	32.5	1.35	0.49	0.00	100	3.50	1.04	3.63	1.43	3.59	0.87	4.17	1.05	43.26	36.39
53	Chaussette	Sock	28.57	32.5	1.58	0.64	0.00	100	3.20	0.85	4.97	0.18	1.79	0.73	3.93	1.17	7.91	2.26
54	Chaussure	Shoe	18.00*	32.5	1.38	0.57	0.00	100	2.90	0.96	4.93	0.25	3.14	0.64	4.14	1.06	14.25	5.00
55	Chemise	Shirt	60.92	74.5	2.04	0.66	0.00	100	3.80	0.92	4.37	0.85	3.10	0.62	3.70	0.99	46.58	38.71
56	Chemisier	Blouse	—	—	2.96	0.82	0.65	64	1.17	0.59	4.47	0.97	3.76	0.79	2.45	0.78	0.63	3.06
57	Chenille	Caterpillar	48.94	68.5	2.65	0.75	0.34	89	3.83	1.21	1.47	0.73	3.83	0.89	2.37	0.81	6.63	1.87
58	Cheval	Horse	18.00*	32.5	1.54	0.71	0.00	100	4.07	0.98	2.63	1.07	3.93	0.65	3.27	1.05	135.00	76.77
59	Cheveux	Hair	97.13**	—	1.23	0.43	0.68	82	1.90	0.76	4.70	0.65	2.41	0.57	4.10	0.71	0.00	139.74
60	Chèvre	Goat	48.56	74.5	2.12	0.86	0.66	79	4.13	0.90	1.80	0.81	3.48	0.57	2.33	0.80	15.23	6.74
61	Chien	Dog	18.00*	32.5	1.19	0.40	0.00	100	2.23	0.77	3.80	1.06	2.76	0.74	4.33	0.76	121.00	69.68
62	Chou	Cabbage	74.61	—	2.48	0.87	*	*	*	*	*	*	*	*	2.20	0.55	10.08	10.90

(Continued)

APPENDIX
(Continued)

Item	Intended name	English	Objective AoA (LR) (months)	Objective AoA (75%) (months)	Rated AoA		Name agreement		Image agreement		Conceptual familiarity		Visual complexity		Image variability		Frequency	
					M	SD	H	%	M	SD	M	SD	M	SD	M	SD	Brulex	Frant
63	Cigare	Cigar	88.26	113.5	2.96	1.04	0.00	100	3.80	0.81	2.00	1.08	3.59	1.05	2.33	0.80	14.12	9.55
64	Cigarette	Cigarette	54.00	68.5	2.38	0.80	0.29	93	3.93	0.94	4.10	1.24	2.17	0.89	2.87	1.07	44.71	40.52
65	Cintre	Hanger	85.59	140.5**	2.88	0.95	0.29	93	4.33	0.84	4.10	0.99	1.00	0.00	2.70	0.92	3.10	1.77
66	Ciseau	Scissors	23.12	32.5	2.00	0.63	0.34	89	4.50	0.73	1.07	0.83	2.24	0.69	3.03	1.03	7.27	2.35
67	Citron	Lemon	38.61	56.5	1.88	0.82	0.00	100	4.83	0.38	3.63	1.10	1.72	0.70	2.53	0.90	5.02	8.06
68	Citrouille	Pumpkin	44.87	92.5	2.77	1.07	0.29	93	3.60	0.89	1.90	0.80	2.34	0.67	2.50	0.82	0.85	1.32
69	Clé	Key	26.42	44.5	1.88	0.71	0.00	100	2.13	0.94	4.97	0.18	2.45	0.51	3.55	0.99	62.5	22.61
70	Cloche	Bell	35.97	44.5	2.19	0.80	0.15	96	3.70	0.79	2.10	0.76	3.00	0.60	2.57	0.73	38.67	15.06
71	Clou	Nail	75.48	74.5	2.31	0.79	0.15	96	4.37	0.76	2.70	0.95	1.66	0.55	2.60	1.07	18.59	5.97
72	Clown	Clown	22.60	32.5	1.52	0.77	0.29	93	3.47	0.90	1.83	0.83	4.41	0.63	2.93	0.98	2.59	4.42
73	Cochon	Pig	22.68	32.5	1.76	0.78	0.60	71	3.60	1.04	1.83	0.87	3.21	0.77	2.43	0.77	17.91	9.06
74	Cœur	Heart	32.32	38.5	1.81	0.80	0.00	100	3.73	1.70	3.50	1.25	1.00	0.00	3.07	1.01	605.00	274.94
75	Collier	Necklace	29.29	44.5	1.86	0.069	0.47	82	3.90	1.03	3.33	1.09	1.79	0.94	3.77	1.19	13.01	8.97
76	Commode	Dresser	137.44**	—	2.96	0.87	0.15	96	3.30	0.88	4.27	0.83	2.83	0.80	3.07	1.05	6.89	23.45
77	Coq	Rooster	49.76	74.5	1.85	0.67	0.00	100	4.43	0.68	2.40	1.30	3.76	0.64	2.43	0.97	18.42	10.81
78	Cor	French horn	129.05	—	4.00	0.98	1.05	61	3.13	1.31	1.53	0.78	4.93	0.26	1.93	0.58	7.06	—
79	Couronne	Crown	34.49	50.5	2.20	0.82	0.00	100	3.33	0.96	1.40	0.62	4.10	0.67	2.77	0.97	28.33	18.42
80	Couteau	Knife	18.00*	32.5	1.65	0.69	0.00	100	2.80	0.81	4.97	0.18	1.59	0.63	3.20	1.10	31.95	26.94
81	Cravate	Tie	57.98	74.5	2.38	0.75	0.00	100	3.80	0.89	3.33	0.92	2.66	0.61	3.07	1.05	1.61	15.45
82	Crayon	Pencil	18.00*	32.5	1.38	0.57	0.00	100	4.23	0.68	4.83	0.38	2.50	0.64	3.83	0.95	19.39	15.55
83	Crocodile	Alligator	28.81	44.5	2.23	0.65	0.29	96	4.23	0.94	1.43	0.73	4.34	0.72	2.37	0.72	3.35	2.55
84	Cuillère	Spoon	18.00*	32.5	1.35	0.56	0.00	100	3.83	0.79	4.93	0.25	2.38	0.68	2.97	1.07	0.00	4.84
85	Cuisinière	Stove	113.68	—	2.88	0.91	1.03	61	2.93	0.69	4.37	1.07	4.24	0.79	3.00	1.05	8.55	9.42
86	Cygne	Swan	67.55	92.5	2.65	0.89	0.15	96	3.73	1.11	1.87	0.86	2.86	0.64	2.23	0.68	8.21	3.71
87	Doigt	Finger	29.31	38.5	1.31	0.47	0.52	79	4.10	0.84	4.90	0.40	2.52	0.74	2.87	1.14	167.00	46.87
88	Drapeau	Flag	48.71	56.5	2.58	0.64	0.00	100	3.13	0.97	2.17	0.95	1.79	0.68	4.07	1.11	21.99	15.16
89	Échelle	Ladder	32.46	50.5	2.27	0.96	0.00	100	3.97	0.91	2.70	1.02	2.59	0.73	2.67	0.92	34.16	48.45
90	Ecrou	Nut	115.40	—	3.92	0.95	0.69	50	3.90	1.45	1.90	1.03	2.21	0.62	2.00	0.64	0.72	1.90

91	Écureuil	Squirrel	35.03	50.5	2.42	0.99	0.00	100	4.33	0.61	1.83	0.95	3.55	0.63	2.33	0.80	4.89	5.19
92	Église	Church	62.60	74.5	2.27	0.87	0.15	96	3.27	0.91	2.97	1.30	3.86	0.74	3.80	1.10	175.00	94.77
93	Éléphant	Elephant	18.20	32.5	2.04	0.82	0.00	100	3.90	0.80	1.40	0.72	4.55	0.57	2.37	0.76	7.01	5.68
94	Enveloppe	Envelope	67.19	80.5	2.58	0.76	0.15	96	4.27	0.87	4.23	0.82	1.00	0.00	2.87	1.11	26.24	23.71
95	Escargot	Snail	33.46	44.5	1.88	0.82	0.00	100	3.77	0.77	2.30	1.06	3.00	0.71	2.67	0.88	4.93	2.42
96	Étoile	Star	18.00*	32.5	1.69	0.68	0.00	100	4.30	1.12	3.77	0.77	1.17	0.47	3.43	1.25	92.10	32.42
97	Fenêtre	Window	50.95	68.5	1.69	0.88	0.00	96	1.77	0.63	3.67	1.32	3.48	0.91	3.57	0.88	196.00	113.29
98	Feu	Traffic light	49.64	68.5	1.65	0.75	0.00	100	2.67	0.88	4.33	0.92	3.41	0.63	3.32	1.25	226.00	156.29
99	Feuille	Leaf	30.38	38.5	1.54	0.65	1.09	61	3.27	1.20	3.60	1.00	2.76	0.64	4.03	1.00	103.00	35.23
100	Flèche	Arrow	44.91	50.5	2.52	0.77	0.00	100	3.83	0.87	1.53	0.73	1.93	0.37	2.80	1.06	17.91	14.10
101	Fleur	Flower	18.00*	32.5	1.40	0.58	0.15	96	3.40	1.04	3.93	0.94	2.93	0.84	4.50	0.68	164.00	32.97
102	Fourchette	Fork	18.00*	32.5	1.42	0.58	0.00	100	4.00	0.83	4.90	0.31	2.66	0.67	2.80	1.13	5.87	6.16
103	Fourmi	Ant	57.88	68.5	1.92	0.69	0.62	82	2.80	1.42	2.30	0.95	4.52	0.57	2.60	1.07	10.5	3.16
104	Fraise	Strawberry	38.18	50.5	1.81	0.85	0.00	100	3.03	1.03	3.20	1.03	2.76	0.69	2.70	1.12	6.12	2.71
105	Frigidaire	Refrigerator	—	—	2.31	0.88	1.01	54	3.83	0.87	4.73	0.52	2.31	0.60	2.53	0.82	0.34	1.81
106	Gant	Glove	32.78	50.5	2.00	0.63	0.00	100	3.23	0.94	3.97	1.25	2.93	0.65	3.30	1.24	22.71	4.39
107	Gâteau	Cake	50.35	74.5	1.27	0.53	0.00	100	2.87	0.90	3.67	0.99	2.34	0.61	4.10	0.99	11.35	9.84
108	Gilet	Vest	127.17	—	2.50	1.03	0.98	64	1.93	1.20	2.43	1.01	2.76	0.64	3.21	0.99	11.4	7.58
109	Girafe	Giraffe	24.57	32.5	2.12	0.81	0.00	100	4.47	0.57	1.30	0.65	4.97	0.19	2.17	0.70	1.19	1.03
110	Gorille	Gorilla	58.37	74.5	2.50	0.91	0.29	93	3.37	0.85	1.40	0.86	3.28	0.75	2.37	0.72	1.44	1.65
111	Grange	Barn	—	—	3.27	0.87	1.12	50	2.40	1.16	2.23	1.43	3.52	0.83	2.57	0.77	17.27	20.97
112	Grenouille	Frog	25.05	38.5	1.92	0.80	0.67	61	4.17	0.87	1.87	0.90	3.69	0.71	2.67	0.88	9.18	6.00
113	Guitare	Guitar	31.74	50.5	2.50	0.071	0.15	96	4.57	0.57	2.90	1.03	3.45	0.78	3.10	1.03	4.33	7.52
114	Hache	Axe	64.62	74.5	2.64	0.76	0.00	96	4.20	1.00	1.57	0.77	2.55	0.69	2.23	0.63	9.35	7.13
115	Haie	Fence	—	—	3.31	0.84	0.77	75	1.53	1.17	3.00	1.14	2.72	0.60	2.70	1.02	20.12	10.48
116	Harpe	Harp	118.31	—	3.42	1.06	0.15	96	4.27	0.94	1.67	1.06	4.76	0.44	2.13	0.51	5.1	3.06
117	Hélicoptère	Helicopter	40.15	50.5	2.72	1.10	0.00	100	3.77	0.68	1.97	0.76	3.48	0.74	2.33	0.66	0.08	1.74
118	Hibou	Owl	41.25	50.5	2.48	0.82	0.52	79	4.37	0.67	1.67	0.80	4.10	0.41	2.30	0.65	3.23	1.48
119	Hippocampe	Sea horse	85.07	*140.5*	3.65	1.16	0.00	96	4.00	1.08	1.20	0.55	4.55	0.63	2.37	0.81	0.12	0.26
120	Homard	Lobster	127.67	—	3.36	1.04	0.73	79	3.93	0.94	2.03	0.93	4.03	0.50	2.07	0.45	1.74	2.13
121	Horloge	Clock	73.86	80.5	2.69	0.97	1.01	54	1.70	0.79	4.73	0.52	2.14	0.79	3.57	0.90	13.86	12.19
122	Interrupteur	Light switch	112.32	*140.5*	3.27	0.96	0.16	93	2.60	0.81	4.66	0.77	2.72	0.88	2.47	0.86	0.00	1.61
123	Jambe	Leg	57.97	74.5	1.40	0.71	0.43	89	3.77	0.73	4.80	0.66	2.34	0.67	2.83	1.12	114.00	36.68
124	Jupe	Skirt	61.81	74.5	1.65	0.69	0.00	100	2.37	0.81	3.23	1.28	1.66	0.55	3.73	0.91	22.07	18.13

(Continued)

APPENDIX
(Continued)

Item	Intended name	English	Objective AoA (LR) (months)	Objective AoA (75%) (months)	Rated AoA		Name agreement		Image agreement		Conceptual familiarity		Visual complexity		Image variability		Frequency	
					M	*SD*	*H*	%	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*Brulex*	*Frant*
125	Kangourou	Kangaroo	40.32	56.5	2.88	1.03	0.00	100	4.37	0.81	1.07	0.37	4.07	0.53	2.17	0.65	0.63	1.10
126	Lampe	Lamp	41.07	50.5	2.04	0.72	0.00	100	2.73	0.87	4.80	0.41	2.00	0.53	3.73	0.94	71.55	42.61
127	Landau	Babycarriage	98.21	*140.5***	2.54	0.99	0.80	79	3.47	1.01	2.07	1.17	3.97	1.02	2.47	0.82	1.57	3.00
128	Lapin	Rabbit	18.00*	32.5	1.65	0.80	0.00	100	4.07	0.78	2.67	1.09	3.14	0.64	2.90	1.06	20.12	10.42
129	Lèvres	Lips	72.40	74.5	1.77	0.71	0.56	75	4.03	0.85	4.77	0.57	1.69	0.60	3.43	1.12	0.00	107.35
130	Lime	Nail file	116.57	—	3.19	0.90	0.00	100	2.23	1.04	3.00	1.41	2.90	0.72	2.00	0.37	1.57	2.16
131	Lion	Lion	34.22	50.5	1.69	0.79	0.00	100	3.53	0.94	1.50	0.82	4.17	0.54	2.33	0.71	17.91	16.94
132	Lit	Bed	28.89	32.5	1.24	0.52	0.51	86	3.40	0.67	4.93	0.37	2.62	0.49	3.73	1.08	204.00	196.39
133	Livre	Book	21.98	32.5	1.50	0.58	0.29	96	4.07	1.05	4.97	0.18	2.14	0.74	4.37	0.85	371.00	144.29
134	Luge	Sled	52.17	56.5	2.81	1.23	0.26	89	2.83	1.02	1.90	0.84	3.28	0.65	2.57	0.57	0.34	1.00
135	Lune	Moon	29.48	44.5	1.77	0.65	0.52	79	3.60	1.19	3.80	0.89	1.03	0.19	3.20	1.16	84.49	52.45
136	Lunettes	Glasses	18.00*	32.5	2.00	0.69	0.15	96	3.73	0.87	4.03	1.16	2.38	0.68	3.87	1.14	0.00	36.61
137	Main	Hand	18.00*	32.5	1.12	0.33	0.00	100	3.80	0.85	4.97	0.18	2.97	0.68	3.10	1.27	892.00	476.97
138	Maïs	Corn	58.57	68.5	2.60	0.87	0.56	75	3.90	1.18	3.10	0.80	4.21	0.68	2.40	0.77	7.48	6.81
139	Maison	House	18.00*	32.5	1.38	0.75	0.00	100	2.53	0.78	4.47	1.01	3.24	0.79	4.37	0.89	507.00	299.65
140	Manteau	Coat	58.78	113.5	1.76	0.83	0.29	93	3.23	0.90	4.53	0.82	2.59	0.63	3.73	1.14	47.94	36.29
141	Marteau	Hammer	40.59	56.5**	2.19	0.75	0.15	96	2.33	0.71	2.10	1.06	2.90	0.72	2.17	0.53	11.69	10.26
142	Montagne	Mountain	45.29	50.5	1.88	0.65	0.29	93	2.83	1.05	2.67	1.27	2.93	0.70	3.70	1.15	101.00	44.32
143	Montre	Watch	30.45	44.5	2.19	0.57	0.00	100	3.23	0.73	4.70	0.60	2.93	0.80	3.61	1.10	27.73	96.26
144	Moto	Motorcycle	18.00*	32.5	2.23	1.03	0.00	100	3.60	0.89	3.00	1.23	5.00	0.00	3.50	0.97	1.57	8.03
145	Mouche	Fly	60.44	74.5	1.77	0.59	0.00	100	3.17	0.75	2.60	0.97	4.62	0.62	2.63	1.03	33.73	12.45
146	Mouffette	Skunk	—	—	4.62	0.64	0.76	71	2.03	1.38	1.07	0.25	4.76	0.64	1.43	0.68	0.00	—
147	Moufle	Mitten	67.14	74.5	2.60	1.35	0.15	96	4.23	0.90	2.77	1.33	2.07	0.59	2.27	0.64	0.46	0.48
148	Moulin	Windmill	50.20	74.5	2.31	0.93	0.00	100	3.33	1.09	1.57	0.77	4.79	0.41	2.36	0.73	18.16	14.52
149	Mouton	Sheep	44.62	74.5	1.65	0.69	0.00	100	2.90	0.80	1.83	0.87	3.59	0.57	2.43	1.04	22.37	11.1
150	Nez	Nose	61.26	74.5	1.12	0.33	0.00	100	3.60	0.89	4.90	0.31	1.79	0.56	3.17	1.23	107.00	95.94
151	Nœud	Bow	49.51	56.5	2.31	0.79	0.00	100	1.57	1.22	2.40	1.00	3.24	0.64	3.07	0.98	23.27	10.9
152	Nuage	Cloud	99.06**	—	1.68	0.63	0.40	89	2.90	0.80	3.87	1.28	2.45	0.91	3.47	0.14	64.11	19.29

153	Œil	Eye	42.58	56.5	1.38	0.57	0.00	100	3.93	0.96	4.90	0.40	3.83	0.76	3.77	1.17	193.00	179.90
154	Oignon	Onion	69.67	92.5	2.58	0.70	0.33	79	2.80	0.89	2.87	1.07	3.59	0.68	2.23	0.86	6.04	4.10
155	Oiseau	Bird	18.35	32.5	1.38	0.57	0.41	86	3.90	1.12	3.87	1.28	3.38	0.86	4.70	0.70	112.00	36.68
156	Orange	Orange	50.83	68.5	1.62	0.75	0.29	93	4.00	0.95	4.03	1.10	1.76	0.69	2.47	1.01	11.65	15.32
157	Oreille	Ear	45.41	50.5	1.35	0.56	0.00	100	4.27	0.78	4.93	0.37	2.97	0.68	2.40	1.10	141.00	64.81
158	Orteil	Toe	101.55	—	2.31	0.97	0.80	54	3.83	0.70	4.60	0.67	2.07	0.59	2.25	0.84	4.25	1.35
159	Ours	Bear	36.71	50.5	1.62	0.75	0.00	100	3.07	1.01	1.60	1.00	3.93	0.80	2.67	0.80	10.12	12.94
160	Panier	Basket	19.74	38.5	1.92	0.69	0.00	100	2.63	0.76	2.30	1.15	4.59	0.57	3.13	0.94	22.59	16.32
161	Pantalon	Pants	18.00*	32.5	1.54	0.76	0.15	96	3.40	0.86	4.87	0.43	2.28	0.53	3.70	1.09	28.46	29.26
162	Paon	Peacock	97.93	140.5**	3.08	1.13	0.00	100	4.07	0.87	1.37	0.81	4.93	0.26	2.13	0.63	4.72	2.84
163	Papillon	Butterfly	27.81	32.5	1.92	0.95	0.00	100	4.37	0.49	2.33	0.88	4.10	0.49	3.57	1.17	16.08	13.03
164	Parapluie	Umbrella	18.00*	32.5	1.88	0.77	0.47	82	3.23	0.73	3.43	0.86	3.24	0.69	3.07	0.90	10.25	6.65
165	Pastèque	Watermelon	102.80	—	2.81	0.90	0.47	82	2.70	1.26	2.53	1.04	1.86	0.58	2.14	0.71	0.68	0.77
166	Pêche	Peach	95.27	—	2.12	1.11	1.12	50	3.50	1.11	2.87	0.94	2.14	0.79	2.47	0.90	12.29	30.65
167	Peigne	Comb	38.61	56.5	2.00	0.75	0.00	100	3.83	0.95	3.87	1.22	2.69	0.66	2.62	0.82	6.08	6.84
168	Phoque	Seal	63.62	74.5	2.96	1.11	0.89	57	2.67	0.88	1.27	0.64	2.86	0.79	2.13	0.63	2.89	1.61
169	Piano	Piano	44.59	56.5	2.00	0.80	0.00	100	3.80	1.16	3.10	1.37	4.72	0.59	2.93	0.94	39.73	20.55
170	Pied	Foot	18.00*	32.5	1.31	0.55	0.00	100	4.33	0.88	4.80	0.66	2.41	0.50	2.90	1.32	333.00	169.65
171	Pince	Pliers	71.74	92.5	3.12	0.99	0.57	86	3.57	1.04	2.07	1.11	2.24	0.69	2.27	0.83	3.48	8.68
172	Pinceau	Paintbrush	38.92	50.5	2.23	0.86	0.15	96	4.10	1.12	2.57	1.25	2.52	0.78	3.03	0.85	9.14	8.81
173	Pingouin	Penguin	53.35	68.5	2.77	0.95	0.15	96	3.27	0.94	1.37	0.93	2.66	0.48	2.17	0.65	0.42	0.84
174	Pipe	Pipe	61.24	74.5	2.46	0.86	0.00	100	3.90	0.80	1.93	0.94	1.93	0.46	2.73	0.94	26.58	16.29
175	Poêle	Frying pan	73.43	92.5	2.73	1.04	0.82	75	2.67	0.71	4.00	1.14	1.93	0.46	2.50	1.04	19.18	9.68
176	Poignée	Doorknob	97.13	—	1.52	0.77	0.29	93	3.30	0.88	4.67	0.61	3.17	0.60	3.40	1.16	0.80	20.94
177	Poire	Pear	35.53	56.5	1.81	0.63	0.00	100	4.40	0.67	3.37	1.03	1.14	0.35	2.50	0.94	5.31	6.42
178	Poisson	Fish	18.00*	32.5	1.62	0.57	0.00	100	3.00	0.83	3.33	0.99	3.48	0.63	4.13	1.01	36.45	30.03
179	Poivron	Pepper	123.68	—	3.23	1.03	0.00	93	3.17	1.12	2.47	1.01	2.62	0.49	2.40	0.81	0.51	0.13
180	Pomme	Apple	18.00*	32.5	1.46	0.58	0.00	100	4.00	0.79	4.40	0.72	1.55	0.63	3.23	0.86	30.41	26.45
181	Porte	Door	21.03	32.5	1.52	0.77	0.29	93	3.30	0.88	4.67	0.61	3.17	0.60	3.40	1.16	0.80	426.48
182	Poubelle	Garbage can	24.51	32.5	1.81	0.63	0.00	100	4.07	1.20	4.37	0.61	3.38	0.56	3.03	1.03	3.19	5.68
183	Pouce	Thumb	46.47	62.5	1.23	0.51	0.15	96	4.27	0.83	4.77	0.68	2.24	0.64	2.46	1.07	19.44	17.87
184	Poule	Chicken	37.86	50.5	1.50	0.58	0.47	82	4.37	0.76	2.30	1.09	3.79	0.86	2.47	0.82	21.82	10.87
185	Poupée	Doll	71.65	—	1.23	0.65	0.94	54	2.00	0.64	3.07	1.01	4.31	0.60	3.83	1.21	10.59	10.90
186	Prise	Plug	84.42	113.5	2.92	0.93	0.00	96	1.83	0.99	3.60	1.07	2.55	0.51	2.23	0.77	47.30	84.55

(Continued)

APPENDIX
(Continued)

Item	Intended name	English	Objective AoA (LR) (months)	Objective AoA (75%) (months)	Rated AoA		Name agreement		Image agreement		Conceptual familiarity		Visual complexity		Image variability		Frequency	
					M	SD	H	%	M	SD	M	SD	M	SD	M	SD	Brulex	Frant
187	Puits	Well	63.09	74.5	2.77	0.99	0.00	100	3.40	1.10	1.90	1.03	3.79	0.56	2.50	0.84	23.73	19.10
188	Raisin	Grapes	43.32	56.5	2.04	0.87	0.29	93	4.20	0.66	3.60	0.97	3.76	0.69	2.73	0.98	11.57	4.39
189	Règle	Ruler	54.57	68.5	2.42	0.76	0.00	100	3.73	0.78	4.53	0.68	2.28	0.75	2.77	0.90	90.78	60.90
190	Renard	Fox	43.03	50.5	2.15	0.88	0.41	86	3.87	0.94	1.47	0.68	4.10	0.56	2.27	0.58	13.27	7.32
191	Revolver	Gun	105.88	—	2.81	0.80	0.73	68	3.57	0.90	1.53	0.73	3.55	0.57	3.03	1.07	21.80	14.90
192	Rhinocéros	Rhinoceros	51.89	74.5	2.96	1.15	0.00	100	4.17	0.87	1.17	0.46	3.93	0.80	2.10	0.66	1.10	8.71
193	Robe	Dress	36.50	50.5	1.46	0.65	0.00	100	1.80	0.66	3.40	1.19	2.07	0.75	4.27	0.98	99.29	65.48
194	Roue	Wheel	35.90	50.5	2.12	0.77	0.00	100	3.73	1.48	1.67	0.84	3.34	0.86	3.43	1.03	5.02	22.58
195	Sacoche	Pocketbook	—	—	3.46	0.81	1.06	50	2.80	1.16	4.37	1.07	2.86	0.52	3.03	0.96	1.57	2.19
196	Salière	Salt shaker	128.64**	—	3.00	0.91	0.29	93	4.33	0.92	4.30	0.88	3.07	0.59	2.50	0.82	0.85	0.74
197	Sandwich	Sandwich	56.28	74.5	2.52	0.87	0.00	100	3.03	1.00	3.93	0.91	3.21	0.68	3.53	1.11	3.78	4.68
198	Sauterelle	Grasshopper	68.48	74.5	2.50	0.86	1.15	54	3.00	1.11	1.63	0.85	4.97	0.19	2.13	0.86	2.93	1.03
199	Scie	Saw	53.56	74.5	2.68	0.90	0.00	100	4.60	0.72	1.97	1.13	2.41	0.68	2.20	0.61	4.21	6.61
200	Serpent	Snake	25.15	38.5	2.23	0.91	0.00	100	3.33	0.92	1.50	0.82	4.00	0.80	3.17	1.05	21.9	11.13
201	Sifflet	Whistle	54.95	68.5	2.38	0.80	0.00	100	4.70	0.60	2.10	0.92	2.24	0.58	2.39	0.63	11.52	7.73
202	Singe	Monkey	28.12	44.5	1.80	0.82	0.43	93	3.03	1.00	1.40	0.72	3.41	0.63	3.37	1.10	16.46	10.39
203	Soleil	Sun	30.07	38.5	1.42	0.64	0.00	100	3.53	1.14	4.37	0.67	1.14	0.35	3.30	1.37	257.00	227.13
204	Souris	Mouse	27.51	32.5	1.62	0.75	0.29	93	4.27	0.74	2.27	1.11	3.38	0.68	2.63	1.03	10.42	26.03
205	Stylo	Pen	55.75	68.5	1.80	0.76	1.10	54	3.50	1.04	4.90	0.40	2.79	0.68	3.83	1.09	3.40	5.68
206	Table	Table	18.00*	32.5	1.35	0.56	0.00	100	3.50	1.17	4.83	0.46	1.45	0.57	3.73	1.11	254.00	200.58
207	Tabouret	Stool	48.16	68.5	2.20	0.87	0.00	100	3.60	0.93	3.80	1.30	2.24	0.69	2.57	0.94	7.48	7.77
208	Tambour	Drum	59.81	74.5	2.15	0.88	0.00	100	3.77	0.68	1.57	0.77	2.79	0.49	2.27	0.83	14.76	9.10
209	Tasse	Cup	51.76	74.5	2.16	0.80	0.15	96	3.60	0.81	4.83	0.46	1.69	0.47	3.50	0.94	21.31	14.61
210	Téléphone	Telephone	23.73	32.5	1.77	0.82	0.00	100	3.20	1.27	4.93	0.25	3.10	0.56	3.75	0.97	37.52	60.19
211	Télévision	Television	71.92	—	2.04	0.77	0.15	96	2.97	0.96	4.43	1.01	3.28	0.53	3.37	1.11	0.46	22.48
212	Tigre	Tiger	31.85	50.5	2.31	1.05	0.00	100	3.63	0.76	1.30	0.65	4.62	0.68	2.25	0.65	5.27	12.42
213	Tomate	Tomato	47.96	56.5	1.65	0.75	0.15	96	4.37	0.85	4.27	0.78	1.93	0.65	2.57	0.92	3.44	3.52
214	Tonneau	Barrel	67.86	74.5	3.15	0.92	0.79	71	4.57	0.73	1.27	0.45	4.10	0.56	2.33	0.71	9.91	4.10

215	Tortue	Turtle	25.76	32.5	1.92	0.80	0.00	100	4.10	0.66	2.03	1.07	3.28	0.65	2.71	0.98	5.57	4.35
216	Toupie	Top	57.79	74.5	2.31	0.93	0.00	100	2.63	0.89	1.80	0.89	3.07	0.75	2.39	0.92	2.51	1.87
217	Tournevis	Screwdriver	53.12	68.5	2.96	0.92	0.00	100	4.37	0.76	2.47	1.33	2.31	0.47	2.30	0.65	0.63	1.74
218	Train	Train	34.67	50.5	1.73	0.92	0.67	61	2.87	0.97	3.97	1.07	4.69	0.47	3.43	0.96	168.00	161.55
219	Trompette	Trumpet	43.34	50.5	2.35	0.85	0.29	93	4.33	0.80	1.90	0.80	3.55	0.87	2.07	0.54	11.91	4.26
220	Vache	Cow	37.64	50.5	1.60	0.76	0.00	100	3.40	0.89	2.63	0.96	3.59	0.68	2.73	0.83	35.26	18.45
221	Valise	Suitcase	45.65	74.5	2.23	0.71	0.43	89	2.77	0.73	3.90	0.99	3.48	0.57	3.20	0.89	25.90	23.77
222	Vase	Vase	56.29	68.5	2.31	0.74	0.15	96	2.20	0.89	2.90	1.21	3.62	0.73	3.68	1.09	25.95	17.84
223	Vélo	Bicycle	26.89	32.5	1.80	0.71	0.41	86	4.20	0.76	3.37	1.03	4.17	0.85	3.57	1.01	4.42	13.00
224	Verre	Glass	25.15	32.5	1.23	0.51	0.00	100	3.63	1.54	4.97	0.18	1.93	0.46	4.07	1.01	98.48	115.29
225	Veste	Jacket	97.20	140.5**	2.69	0.79	0.56	75	1.87	0.73	4.23	1.07	3.45	0.74	3.66	0.97	20.63	27.68
226	Violon	Violin	68.83	74.5	2.54	1.07	0.15	96	4.27	0.69	2.03	0.96	4.28	0.65	2.36	0.78	13.86	8.06
227	Vis	Screw	76.82	92.5	2.77	0.95	0.15	96	3.87	1.04	2.30	1.15	3.55	0.87	2.23	0.68	2.68	95.48
228	Voilier	Sailboat	119.35	—	3.12	0.93	0.80	57	3.67	0.80	2.87	1.01	3.41	0.87	3.37	1.03	3.99	2.23
229	Voiture	Car	18.00*	32.5	1.40	0.58	0.15	96	3.00	0.95	4.53	1.07	3.83	0.54	4.43	0.82	118.00	123.13
230	Zèbre	Zebra	37.51	50.5	2.46	0.95	0.00	100	4.27	0.69	1.07	0.37	4.55	0.51	2.04	0.43	1.61	1.71

The objective scores are as follows: LR used the logistic regression curve-fitting procedure (values extrapolated below the 30-month mark are indicated with an ''*''), and 75% used the 75% rule (values extrapolated above the 130-month mark are indicated by italics). ''**'' denotes outliers whatever the procedure used (LR or 75%).