DO IDENTICAL PRIMING AND WORD FREQUENCY TRULY INTERACT IN PICTURE NAMING WHEN A NEUTRAL BASELINE IS USED?

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Abstract. According to La Heij, Puerta-Melguizo, van Oostrum and Starreveld (1999), identical priming and word frequency are generally assumed to affect the same processing level in picture naming: the phonological level. Therefore, identical priming and word frequency are usually expected to interact. However, Ferrand and colleagues (1994, 1998) have found that, in picture naming, word frequency and identical priming combined additively. La Heij et al. (1999) have argued that this result was due to the use of unrelated words as the baseline to assess identical priming effects. A masked form priming picture naming experiment was conducted in which three types of primes were used (identical, unrelated, neutral) and word frequency was manipulated. Word frequency and identical priming did not interact when neutral primes were used as the baseline. The findings therefore challenge the putative claim that word frequency and identical priming should interact in picture naming when neutral primes are used as the baseline.

Keywords: Identical Priming, Neutral Baseline, Word Frequency, Age of Acquisition

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A large number of studies have investigated the various factors that affect the speed of spoken picture naming in normal adults (Barry, Morrison, & Ellis, 1997; Bonin, Chalard, Méot, & Fayol, 2002; Ellis & Morrison, 1998; Lachman, Shaffer, & Hennrikus, 1974; Snodgrass & Yuditsky, 1996; Vitkovitch & Tyrrell, 1995). Among these factors, word frequency, age-of-acquisition (AoA) and identical priming have received much attention. The present study focuses on word frequency and identical priming and their relationship in picture naming. However, given the growing importance of the AoA issue in picture naming, we shall briefly return to it in the discussion.

Word frequency is probably the most established effect in psycholinguistics. It has been robustly found in a large variety of lexical processing tasks such as lexical decision (Bonin, Chalard, Méot, & Fayol, 2001; Brysbaert, Lange, & Van Wijnendaele, 2000; Gerhand & Barry, 1999; Morrison & Ellis, 1995; Turner, Valentine, & Ellis, 1998), word reading (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 picture naming (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). As far as picture naming is concerned, this effect corresponds to the fact that high-frequency (HF) names are produced faster and more accurately than low-frequency (LF) names.

"Identical" priming refers to the observation that the processing of an item is facilitated when it has been immediately preceded by "itself" rather than by another item. This effect is also one of the most robust effects reported in visual word recognition (Forster & Davis, 1984, 1991; Lukatela, Frost, & Turvey, 1999; Lukatela, Savic, Urosevic, & Turvey, 1997; Segui & Grainger, 1990) and it has frequently been reported in speech production (Ferrand, Grainger, & Segui, 1994; Ferrand, Humphreys, & Segui, 1998; Ferrand, Segui , & Grainger, 1995; La Heij et al., 1999). As far as picture naming is concerned, the identical priming effect corresponds to the observation that speaking aloud the name of a picture is facilitated when the picture has just been preceded by its written name than when it has been preceded by a different, unrelated written word. Identical priming effects are short-lived phenomena since, for instance, they do not persist longer than 500 ms in word naming (Ferrand, 1996). Identical priming and "repetition" priming in picture naming are close and related phenomena but, nevertheless, it is necessary to distinguish between them. Repetition priming refers to the observation that spoken naming performance is facilitated when it is preceded by a stimulus that requires the same response (Barry, Hirsh, Jonston,

& Williams, 2001; Griffin & Bock, 1998; Monsell, Matthews, & Miller, 1992; van Berkum, 1997; Wheeldon & Monsell, 1992), whereas identical priming refers to the observation that the picture's name, when presented shortly before the picture *in the same experimental trial* facilitates picture naming (Ferrand et al., 1994, 1995, 1998; La Heij et al., 1999). In the present study, we focused on identical priming.[1]

A controversy surrounding the identical priming effect in picture naming is whether or not it is modulated by word frequency. Determining whether identical priming and word frequency truly interact in picture naming is important from a theoretical point of view since the observation of an interaction between the two factors has been taken to argue that both effects are probably localized at the same processing level: the phonological level (La Heij et al., 1999), as we shall explain.

Repetition priming studies have generally shown that repetition interacts with word frequency: LF names benefit more from repetition than HF names (Griffin & Bock, 1998; van Berkum, 1997; Wheeldon & Monsell, 1992, but see Jescheniak & Levelt, 1994). In contrast, research on identical priming has not yielded a consistent picture. As far as picture naming is concerned, some authors have reported reliable independent effects of both word frequency and identical priming but no interaction (Ferrand et al., 1994; Ferrand et al., 1998) whereas others have reported that word frequency and identical priming interact (La Heij et al., 1999), with the result that LF names exhibit larger priming effects than HF names. More precisely, with the use of the masked form priming paradigm, Ferrand and colleagues (1994, 1998) reported that identical priming and word frequency combined additively. In this technique, the primes are presented briefly and are masked. In these conditions, little information is available from the primes as assessed by the participants' visibility estimations. It is assumed that this paradigm avoids the contribution of episodic memory traces and prevents the involvement of predictive strategies. In contrast to Ferrand and colleagues' studies, La Heij et al. (1999) have found that word frequency and identical priming interact when neutral primes are used as the baseline against which identical priming effects are measured, with the result that priming effects are larger for LF than for HF words. As we shall present in more detail, according to these authors the lack of an interaction in the Ferrand et al. (1994, 1998) studies was most probably due to the use of unrelated primes as the baseline against which identical priming was measured. The goal of the present study was to assess further whether such a conclusion is warranted in

1.The distinction between identical and repetition priming was adopted to keep in with existing terminology. We acknowledge, however, that in studies in which written words are used as primes and pictures as targets, the stimuli are not strictly speaking "identical".

picture naming with the use of the masked form priming paradigm. More particularly, since the criticisms were raised specifically against the Ferrand and colleagues (1994, 1998) studies, we thought it appropriate to use the stimuli that they used in their French study (Ferrand et al., 1994) in which no reliable interaction was found between word frequency and identical priming, but this time with the inclusion of neutral primes in addition to unrelated primes as baselines.

Locus of identical priming and word frequency effects

Some empirical evidence suggests that identical priming effects originate at the phonological level in visual word recognition (Lukatela et al., 1999; Lukatela et al., 1997) as well as in picture naming (Ferrand et al., 1994, 1995, 1998). The phonological locus account of identical priming effects in spoken picture naming is based on the findings that: (1) using the masked form priming paradigm with short prime durations, Ferrand et al. (1994) observed that the prior masked visual presentation of the same phonological word form facilitated picture naming irrespectively of whether the prime was the picture name itself or a pseudohomophone derived from the picture name; (2) using the same paradigm, Ferrand et al. (1995) showed that when the prime was a homophone of a picture, i.e., *rows* for the picture of a *ROSE*, the size of the facilation effect relative to an unrelated word was practically the same as when the prime was the picture name, i.e., *rose*. Given that the homophone primes in the latter study were semantically unrelated to the picture targets, the facilitation induced by a homophone suggests that its visual presentation is sufficient to activate phonological representations that are involved in picture naming (see also, Ferrand et al., 1998).

As far as word frequency effects in picture naming are concerned, evidence in favor of a phonological level (i.e., the lexeme level) locus of these effects was provided by Jescheniak and Levelt (1994). These authors showed that frequency effects were not found in either an object recognition (see also, Wingfield, 1967, 1968) or in a delayed word production (see also Forster & Chambers, 1973) task. Because these tasks are assumed to index conceptual representations (Morrison, Ellis, & Quinlan, 1992) and articulatory components (Balota & Chumbley, 1985) respectively, by a process of elimination, Jescheniak and Levelt (1994) concluded that word frequency effects are lexical effects. In their modelling of lexical access in speech production, they identified three possible loci for word frequency effects: the lemma level, the links between the lemmas and the lexemes, or the lexeme level itself. The argument for localizing frequency effects at the level of lexemes rather than at the level of lemmas, or in the links between lemmas and lexemes stemmed from an experiment in which participants had to say homophones aloud. According to Levelt, Roelofs and Meyer (1999), homophones differ at the conceptual level and at the lemma level while still sharing the same phonological representation, as for example the two words *boy* and *buoy* which correspond to HF and LF nouns respectively. According to Jescheniak and Levelt (1994), if word frequency is coded at the lemma level or in the links between lemmas and lexemes, *buoy* should be as difficult to access as a matched LF nonhomophone word. However, if the frequency of the words lies at the lexeme level, an LF homophone should be accessed just as quickly as its HF twin because both words share the same phonological form. Jescheniak and Levelt (1994) used a translation task to test for these alternative hypotheses. Dutch participants with a good mastery of English were presented with the English translation equivalent of Dutch LF homophones. When presented with a word, they had to say aloud the translation. The important result was that LF homophones were statistically as fast as their matched HF (nonhomophone) controls and faster than the LF frequency controls. These findings suggested then that an LF homophone inherits the frequency of its HF twin. However, two recent studies have clearly challenged this latter conclusion (Bonin & Fayol, 2002; Caramazza, Costa, Miozzo, & Bi, 2001). Therefore, the idea that word frequency specifically lies at the phonological lexeme level in picture naming is at present not warranted and, therefore, alternative accounts of the locus of word frequency in picture naming remain possible, e.g., the links between semantic codes and phonological codes (McCann & Besner, 1987; Wheeldon & Monsell, 1992) or, more precisely, between lemmas and lexemes (Barry et al., 1997), or, even more generally, between the links relating different sublexical representations (Ellis & Lambon Ralph, 2000).

As we have presented above, because some researchers have localized both word frequency and identical priming at the phonological level, the application of the additive-factors logic of Sternberg (1969) would lead to predict an interaction between the two variables (La Heij et al., 1999). La Heij et al. (1999) conducted a series of four experiments. In their first experiment, they tried to replicate the results obtained by Ferrand et al. (1994, 1998) with masked primes, using the same set of words as unrelated primes in the high and low frequency conditions (in contrast to Ferrand, 1994, 1998, who used different words as unrelated primes in the high and low frequency conditions) and found that identical priming and word frequency did not interact. In a second experiment, they showed that the absence of a reliable interaction between identical priming and word frequency was not due to the use of the masked priming paradigm because, using the same stimuli, they replicated the absence of a reliable interaction between identical priming and word frequency when the primes were not masked.

A third experiment (using unmasked primes), in which neutral primes (a series of Xs) were added, revealed that, when the neutral primes were used as the baseline, word frequency and identical priming interact reliably. Finally, the interaction between identical priming and word frequency was replicated in a fourth experiment in which the primes were masked and, instead of unrelated prime words, a series of Xs was used as the baseline condition. To summarize, La Heij et al. (1999) have provided evidence that the discrepancy between identical priming with regard to word frequency most probably stemmed from the use of unrelated words as the baseline against which identical priming was measured. More precisely, according to La Heij et al. (1999), the absence of an interaction between word frequency and identical priming in picture naming when unrelated words are used as baselines would be due to the fact that, when the SOA between prime and target is small, unrelated words interfere with picture naming. Therefore, the identical priming effect, defined as the difference between the unrelated prime and identical prime conditions, would consist of a facilitation induced by the identical primes and an interference effect induced by unrelated primes, and when the overall priming effect is measured, an interaction in the facilitation scores may go unnoticed.

Given the implication that the finding of such an interaction may have in picture naming, in the present study, we re-addressed the question of whether word frequency and identical priming interact in picture naming when both unrelated and neutral baselines are used. In the following experiment, participants were presented with pictures they had to name. The pictures were preceded by primes that were presented for 34 ms and were masked. Three kinds of primes were used: identical (the written name of the picture), neutral (a series of "X"), unrelated (a word different from the picture name but sharing the initial phoneme). According to La Heij et al. (1999), word frequency and identical priming should not interact when unrelated words are used as the baseline. Since, according to them, the identical priming effect, defined as the difference between the unrelated prime and identical prime conditions, consists of a facilitation induced by the identical primes and an interference effect induced by unrelated primes, we should observe facilitation and interference effects respectively, when neutral primes are used as the baseline. Also, word frequency and identical priming should interact when neutral primes are used as the baseline, that is to say a larger identical priming effect should be observed for LF than for HF words.

Method

Participants. Twenty-seven psychology students from Blaise Pascal University (Clermont-Ferrand) were involved in the experiment. All were native speakers of French and had normal or corrected-to-normal vision.

Stimuli. Thirty-six out of the 40 primes and target picture names from the Ferrand et al. (1994) study were used. The thirty-six black-and-white drawings were taken from the Snodgrass and Vanderwart (1980) database. Half of the pictures had a HF name and the remaining half a LF name. For each target picture, three primes were selected: (1) words that corresponded to the name of the pictures (identical primes), (2) words that were unrelated to the target pictures (unrelated primes), and (3) a series of "Xs" that corresponded to the picture name length in terms of number of letters (neutral primes). For each picture, both the identical and the unrelated primes shared the initial phoneme and letter as the target name. The two types of word primes were matched on a number of relevant variables which are presented in Table 1 with their mean statistical characteristics.

Prime-target pairs were rotated across the priming conditions in three blocks, with the constraint that no block contained any single prime or target more than once but that each block contained all priming and word frequency conditions. Each block was composed of 36 prime-target pairs randomized individually for each participant. Each participant saw the three blocks. The order of blocks was counter-balanced across participants using a latin-square design. Therefore each picture was presented three times to the participants. Six additional pictures were used as warm-ups.

Apparatus. The experiment was performed with PsyScope - version 1.2. (Cohen, MacWhinney, Flatt, & Provost, 1993) and run on a PowerMacintosh. The computer controlled the presentation of the pictures and recorded the latencies. The spoken latencies were recorded with the Button-Box connected to the computer and an AIWA CM-T6 small tie-pin microphone connected to the Button-Box.

Procedure. The participants were tested individually. During a preliminary phase, they had to learn to associate correctly the name corresponding to each picture. To this end, the participants were given a booklet showing the target pictures together with their appropriate names. As soon as they said they had looked at all the drawings and studied their names, the experimenter tested them on several pictures selected randomly to ensure that they had correctly learned the names associated with the pictures. In the experimental

Table 1
Statistical characteristics of the identical and unrelated primes used in the experiment

	Identical(HF)	Unrelated(HF)	Identical(LF)	Unrelated(LF)
Nb of letters	5.67	5.67	5.78	5.78
NB of phonemes	3.89	4.56	3.89	4.11
Nb of syllables	1.50	1.72	1.50	1.61
Frequency*(log)	16346.11(3.96)	21866.67(4.02)	1041.33(2.88)	1449.72(2.88)
Bigram frequency**	1169.55	1694.53	1196.30	1621.24
G-count	2.67	2.06	2.72	1.89
P-count	6.78	6.44	5.94	5.83
Nb of high G	0.44	0.28	0.56	0.44

Notes: HF=high-frequency targets; LF= low-frequency targets; Nb= number; * Frequency for 100 million from Imbs(1971); ** from Content & Radeau (1988); G-count= Nb of orthographic neighbors; P-count= Nb of phonological neighbors; Nb of high G= nb of higher frequency orthographic neighbors phase, the participants sat in front of the computer screen at a viewing distance of approximately 60 cm. A trial consisted of the following sequence of events: A forward pattern mask was presented in the center of the screen for 500 ms. This mask was immediately followed by a prime (presented in uppercase letters) that remained visible for 34 ms (i.e., two refresh cycles) and was followed by a backward pattern mask presented for 17 ms. The pattern masks consisted of a row of 10 Japanese characters in the font Hiragana Brush-24. The picture was presented on the screen until the participant initiated the response. The intertrial interval was 5 s. The participants were required to concentrate on the center of the screen and to name the picture as quickly as possible. They were not informed of the presence of the primes. The experimenter sat near the participant to record the responses. Practise trials were given at the begining of the experiment proper.

RESULTS

Observations were discarded from the latency analyses in the following cases: The participant did not remember the picture name, a technical problem occurred, an item other than the expected one was produced, or a non-linguistic sound was produced. Moreover, latencies exceeding two standard deviations above the participant and item means were discarded (0.3% of the data). Overall, 6.1% of the observations were excluded.

Latencies and errors were subjected to ANOVAs with Repetition (first, second, third), Frequency (high frequency: HF, low frequency: LF) and Priming condition (identical, unrelated, neutral) as experimental factors. ANOVAs were carried out on the participant means (F1) and on the item means (F2).

The mean latencies (in ms) and the error rates (in percentages) are presented in Figure 1.

Error rates. There were more errors on LF names than on HF names, $F_1(1, 26) = 34.75$, $MSE = .0095011$, $p < .001$; $F_2(1, 34) = 6.13$, $MSE = .035885$, $p < .05$. The error rate decreased significantly with repetition of the pictures, $F_1(2, 52) = 7.36$, $MSE = .011473$, $p < .01$; $F_2(2, 68) = 8.45$, $MSE = .0066615$, $p < .001$. No other main effect or interaction was significant.
Latencies. The main effect of Repetition was significant, $F_1(2, 52) = 28.51$, $MSE = 9202.71$, $p < .001$; $F_2(2, 68) = 67.58$, $MSE = 2763.15$, $p < .001$,

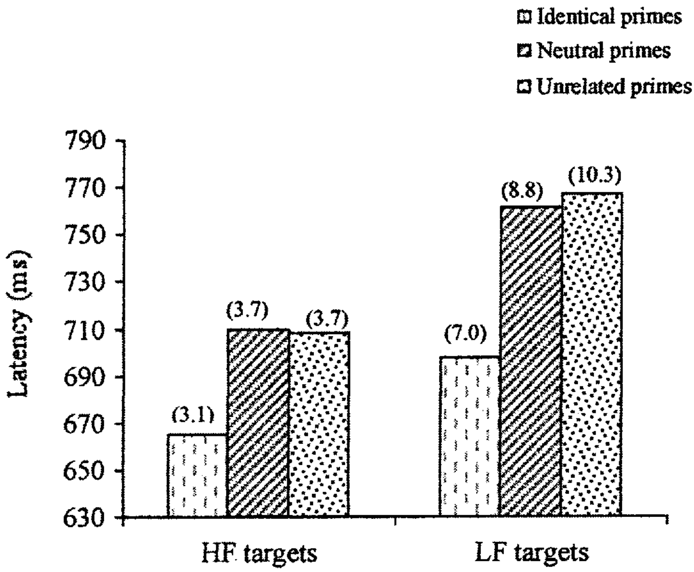

Figure 1. Latencies (in ms) and percentages of errors (in parentheses) as a function of priming conditions (identical, neutral, unrelated) and word frequency (HF: high-frequency words, LF: low-frequency words)

with latencies decreasing with repetition of the targets. However, none of the interactions involving the Repetition factor were significant. Therefore, the data were collapsed across repetitions for the subsequent analyses.

HF names were produced faster than LF ones, $F_1(1, 26) = 36.57$, $MSE = 2528.97$, $p < .001$; $F_2(1, 34) = 5.18$, $MSE = 14330.50$, $p < .03$. The main effect of Priming condition was significant, $F_1(2, 52) = 31.78$, $MSE = 1747.02$, $p < .001$; $F_2(2, 68) = 49.30$, $MSE = 874.01$, $p < .001$. The interaction of Priming condition with Word frequency was not significant, $F_1(2, 52) = 2.13$, $MSE = 1191.36$; $F_2(2, 68) = 2.67$, $MSE = 874.01$, a finding which indicates that the size of the priming effects did not vary across the two frequency levels (see Figure 1). Identical priming yielded shorter latencies when compared to both unrelated and neutral primes for HF, $F_1(1, 26) = 44.24$, $MSE = 797.51$, $p < .001$; $F_2(1, 34) = 20.54$, $MSE = 1261.69$, $p < .001$, and for LF targets, $F_1(1, 26) = 38.53$, $MSE = 2081.51$, $p < .001$; $F_2(1, 34) = 51.11$, $MSE = 1261.69$, $p < .001$. Unrelated and neutral primes did not differ reliably for HF, $F_s < 1$, and LF targets, $F_s < 1$.

DISCUSSION

The main findings are easily summarized. A reliable identical priming effect was observed when compared to both unrelated and neutral primes for both HF and LF words. However, the size of the priming effects did not vary reliably as a function of word frequency. As compared to neutral primes, unrelated primes did not yield longer naming latencies for either HF or LF words. The pattern of results does not support the claim put forward by La Heij et al. (1999) that a possible account for the absence of a reliable interaction between word frequency and identical priming is due to the use of unrelated words as the baseline. According to La Heij et al. (1999), an interaction between identical priming and word frequency should manifest itself when neutral primes are used. Contrary to this prediction, we did not find that the identical priming effect was reliably greater for LF than for HF targets as compared to both baselines (neutral and unrelated). La Heij et al. (1999) have argued that a plausible account for the lack of an interaction between word frequency and identical priming when unrelated words are used as the baseline is that facilitation is induced by identical primes whereas interference is induced by unrelated primes with the net result that an interaction between the two factors may go unnoticed. In contrast to this prediction, we did not find any sign of an interference induced by unrelated primes.

Given that the observation of a reliable interaction between word frequency and identical priming has been taken as support that both of these effects are located at the phonological level, the lack of such an interaction in the present study strongly suggests that such a conclusion is not warranted. In brief, our finding that word frequency and identical priming combine additively is in line with a large body of empirical evidence from various lexical processing tasks[2] (e.g., naming: Ferrand et al. 1994; Sereno, 1991; lexical decision: Forster & Davis, 1984; Jacobs & Grainger, 1992; Segui & Grainger, 1990; perceptual identification: Humphreys, Besner, & Quinlan, 1988; Humphreys, Evett, & Quinlan, 1990.

2. It is important to note here that we found exactly the same pattern of results in a written picture naming task conducted with the same stiluli and procedure but using different participants. This experiment is not reported in the present paper since the focus is on spoken picture naming. However, the similarity of the findings between the two tasks suggests that the observation that word frequency and identical priming combine additively is a general phenonmenon and that the mechanisms which underlie these effects are similar in both production modes.

In comparison with the Ferrand et al. (1994) results, in terms of percentage of naming latencies, it is noteworthy that the size of the facilitation effect with unrelated words used as the baseline was a little higher (+8%) than that reported by Ferrand et al. (1994), i.e., +6.8%. This difference might be attributed to the use of different participants, and/or to differences in the visibility of the primes (29 ms in Ferrand et al.'s (1994) study). As far as the visibility of the primes in our experiment is concerned, it had already been estimated in an earlier related study in which the same masks and prime duration were used (Bonin, Fayol, & Peereman, 1998). To assess the amount of information available to awareness, a sample of 18 well-trained students had to write down every letter they saw (or thought they saw) from the prime. Visibility was assessed on the basis of the structure an experiment trial in the experiment proper, that is to say the prime was followed by the picture. The mean percentage of correct identification was 11%. This percentage of correct identification of the primes is very close to the one reported by Ferrand et al. (1995), i.e., 10%, in which a prime exposure duration of 29 ms was used, and in which the primes were forward and backward masked for 500 ms and 14 ms respectively. Moreover, the observation that the identical priming effects were not modulated with the repeated presentation of the prime-target pairs (as observed in word reading, Ferrand, 1996, or in naming digits, Ferrand, 1995), that is to say, that these effects remain robust even after participants had become very familiar with the stimuli, strongly suggests that they are underpinned by automatized and mandatory processes.

As explained above, the observation of a significant interaction between word frequency and identity priming in spoken picture naming is what is most expected given that these two effects are often assumed by some authors to take place at the same processing level: the retrieval of phonological forms. Although the data reported by La Heij et al. (1999) has provided clear empirical support for this hypothesis, our data clearly show that the interaction between word frequency and identical priming is not reliably observed even when neutral primes are used as the baseline. Therefore, the finding of such an interaction with the use of neutral primes as baselines is not as straighforward as it has been assumed. Given that the presence of an interaction between word frequency and identical priming has been taken to suggest that the two factors affect the same processing level, conversely, the absence of such an interaction might well be taken to suggest that they affect different processing levels. Indeed, such an account was put forward by Ferrand et al. (1998). Ferrand et al. (1998) acknowledged the possibility that word frequency influences the links between semantic and phonological representations (for an identical claim, see Wheeldon & Monsell, 1992), but not the phonological representations themselves (note also that a similar claim has been made that word frequency lies in the links between lemmas and lexemes, Barry et al., 1997). Written word primes would preactivate the phonological representations corresponding to the picture names themselves and these priming effects would combine additively with the effects of word frequency which alter the speed with which the links between semantic and phonological representations are traversed. Our study was not aimed at determing the precise locus at which word frequency and identical priming take place. More work is clearly needed to shed light on the issue. The most important point here is that the mere claim that word frequency and identical priming should interact when neutral primes are used as the baseline is discounted by the present data. The implication is therefore that one should be cautious when referring to the interaction between word frequency and identical priming to argue that these factors most probably affect the same processing level in picture naming, that is to say, the phonological level.

As we noted in the introduction, an aspect that deserves some discussion is related to the important AoA issue in picture naming. In effect, in recent years, a controversy has surrounded word frequency effects in picture naming. Some authors have claimed that putative word frequency effects are actually AoA effects (Morrison et al., 1992), while others have reported effects of both variables (Barry et al., 1997; Ellis & Morrison, 1998), and, more recently, two picture naming studies found no reliable word frequency effect when sets of words were matched on AoA (Barry et al., 2001; Bonin, Fayol, & Chalard, 2001). Also, Barry et al. (2001) have recently provided evidence that repetition priming (which is close to, but not similar to, identical priming as already stressed) interacts with AoA whereas word frequency does not. According to Barry et al. (2001), repetition interacts with AoA because it facilitates the retrieval of the lexical phonology required for naming which benefits late-acquired words differentially. Determining which of AoA or word frequency is the key variable that might truly interact with identical priming in picture naming was beyond the scope of our study. Nevertheless, we performed some additional analyses in an attempt to provide some answers as regards the AoA issue. As will become clear, these analyses have revealed very important and interesting results. Given that our stimuli were not matched on AoA, when the AoA scores for the picture names were considered (rated AoA scores were taken from the Alario and Ferrand (1999) database), we found that word frequency was indeed confounded with AoA, with HF words being acquired significantly earlier than LF words. Note that the AoA scores were obtained using 5-point scales with three-year age bands in between with 1 = acquired at 0-3 and 5 = acquired at 12 or later. AoA scores for words were then introduced as covariates in the by-item analysis on the latencies. It appeared that the main effect of word frequency no longer reached significance whereas the main effect of the covariate, AoA, was significant. The main effect of priming condition was also significant. As far as word frequency is concerned, it should be noted that the observation that the effect of word frequency vanishes when AoA is introduced as a covariate is perfectly in line with two recent picture naming studies which have found that word frequency was not significant when picture names were matched on AoA (Barry et al., 2001; Bonin et al., 2001). More importantly, when the AoA (continuous variable) X Priming condition and the Word frequency X Priming condition interactions were introduced into the analysis, we found that AoA interacts significantly with priming condition whereas word frequency does not. The form of the interaction between AoA and priming condition was such that the identical priming effect was larger for words which tend to be acquired later in life than for words acquired earlier when compared to the unrelated and the neutral priming condition respectively. It should be recalled here that Barry et al. (2001) did indeed find that AoA and not word frequency truly interacted with *repetition priming*. Therefore, as the above analysis strongly suggests, the discrepancy that is noted in the literature concerning word frequency and its interaction with identical priming in picture naming seems to be related to the failure to control for AoA. In effect, none of the studies on identical priming in relation to word frequency has controlled for AoA. If future studies confirm that AoA, and not word frequency, is the key variable that truly interacts with identical priming in picture naming, whatever the baseline that is used, then La Heij et al. (1999) were right in claiming that one should find an interaction since, as it is the case for identical priming, most accounts of AoA have localized the impact of this variable at the level of phonological representations (Barry et al., 1997; Ellis & Morrison, 1998; Morrison et al., 1992; Morrison, Hirsh, Chappell, & Ellis, 2002). However, La Heij et al. (1999) were wrong in claiming that it is *word frequency* that should interact with identical priming in picture naming. Although beyond the scope of the present study, it is already clear from the above discusion that future studies should be specifically aimed at determining in a more systematic manner whether AoA interacts with identical priming in picture naming when word frequency is controlled for (and the reverse). A study of this kind would probably help us obtain a better understanding of the discrepancy that has been set out in the picture naming literature as regards the interaction between word frequency and identical priming. Finally, in contrast to La Heij et al. (1999) who found that "series" (i.e., the number of presentations of the pictures) interact with word frequency, we did not find that "repetition of the pictures" across experimental blocks interacts with word frequency. When the same kind of analysis as is described above was performed in order to specifically examine the AoA X Repetition and the Word frequency X Repetition interactions respectively, we did not find that repetition interacts reliably with AoA or with word frequency. Therefore, we are left with no explanation to account for this discrepancy. It should be recalled, however, that a number of previous picture naming studies also failed to find an interaction between word frequency and repetition of the pictures across experimental blocks (e.g., Jescheniak & Levelt, 1994; Levelt, Praamastra, Meyer, Helenius, Salmelin, 1998).

In conclusion, the present study has shown that "word frequency" and identical priming are not necessarly found to reliably interact in picture naming even when neutral primes are used as the baseline in contrast to the claim made by La Heij et al. (1999). It is already clear that more work is needed in order to gain a better understanding of the mechanisms that give rise to these effects and the reason(s) why the interaction between word frequency and identical priming is found in some studies and not in others. We have suggested that a promising avenue in sheding light on this issue might be to take AoA into accôunt in addition to word frequency when investigating identical priming in picture naming. Another promising approch, not hitherto envisaged, that might be pursued in order to resolve some of the discrepancies found in identical priming studies in picture naming would be to use the incremental priming technique (e.g., Jacobs, Grainger, & Ferrand, 1995; Ziegler, Ferrand, Jacobs, Rey, & Grainger, 2000). In this technique, the prime's informational value is gradually increased and the minimum-intensity level serves as a within baseline for each priming condition. The use of this technique makes it possible to define any observed priming effect with respect to two baseline conditions. The first one is a *within-condition baseline* and consists in the minimum intensity condition of the particular priming condition whereas the second one is a different – *across-condition baseline* – priming condition (e.g., unrelated, neutral conditions as used in the present study). In word recognition, this approach has already been employed (Jacobs et al., 1995; Ziegler et al., 2000) and has proven to be fruitful. In effect, it has been shown that the measuring of priming effects by means of this double-baseline approach is made more reliable and, as consequence, the interpretations of these effects are more secure.

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