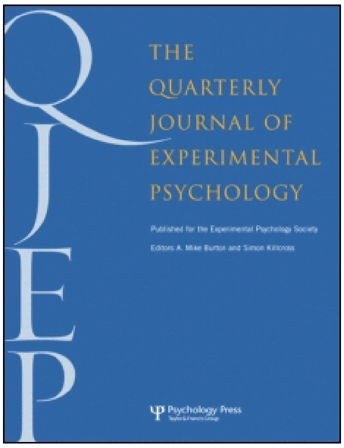

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Name-picture verification as a control measure for object naming: A task analysis and norms for a large set of pictures

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Name–picture verification as a control measure for object naming: A task analysis and norms for a large set of pictures

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The name–picture verification task is widely used in spoken production studies to control for nonlexical differences between picture sets. In this task a word is presented first and followed, after a pause, by a picture. Participants must then make a speeded decision on whether both word and picture refer to the same object. Using regression analyses, we systematically explored the characteristics of this task by assessing the independent contribution of a series of factors that have been found relevant for picture naming in previous studies. We found that, for "match" responses, both visual and conceptual factors played a role, but lexical variables were not significant contributors. No clear pattern emerged from the analysis of "no-match" responses. We interpret these results as validating the use of "match" latencies as control variables in studies or spoken production using picture naming. Norms for match and no-match responses for 396 line drawings taken from Cycowicz, Friedman, Rothstein, and Snodgrass (1997) can be downloaded at: http://language.psy.bris.ac.uk/name-picture_verification.html

Keywords: Name–picture verification; Name–picture matching; Object naming; Norms.

Timed picture naming has often been used to elicit oral responses in the study of speech production (for reviews, see Glaser, 1992; Johnson, Paivio, & Clark, 1996). Despite the differences in details, most accounts of picture naming (e.g., Ellis, Kay, & Franklin, 1992; Snodgrass & McCullough, 1986; Glaser, 1992; Humphreys, Riddoch, & Quinlan, 1988; Levelt, Roelofs, &

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Meyer, 1999; Warren & Morton, 1982; but see Ratcliff & Newcombe, 1982) include access to three distinct representational levels: (a) the picture's *structural description* or visual code; (b) its *semantic representation* containing its functional and associative characteristics; and (c) the *lexical representation* of the picture's name. The first step in the process of naming a picture is object identification, in which the perceived image activates the corresponding representation stored in long-term memory (if there is one matching the stimulus). These stored mental representations have been conceptualized by Seymour (1979) as "pictogens" (drawing a parallel with so-called logogens in word recognition; see Morton, 1969), while Humphreys et al. (1988) refer to them in terms of "stored structural descriptions". Once an object has been recognized, functional and associative information related to it is activated giving access to its meaning. There are two main views about the way in which lexical representations are accessed during picture naming. One view proposes that phonological forms (lexemes) can be activated directly from semantics (e.g., Caramazza, 1997; Humphreys et al., 1988; Morton, 1985), while other authors (e.g., Garrett, 1980; Jescheniak & Levelt, 1994; Kempen & Huijbers, 1983; Levelt, 1989) propose the intervention of an intermediate *lemma* level between semantics and lexemes. The lemma level is thought to include language-specific grammatical information associated with words. On some models, processing between stages is assumed to be modular and discrete. For example, according to Levelt et al. (1999), a lemma must be selected before any activation is passed to the lexeme level. Other models adopt an interactive architecture, in which activation is transmitted continuously between levels of processing. For instance, in such models, phonological representations can be activated before semantic access has been completed (Dell, 1986); likewise, in other models, semantic representations can be activated before a structural description is completely processed (e.g., Humphreys, Lamote, & Lloyd-Jones, 1995; Humphreys, Riddoch, & Price, 1997).

It should be noted that there are alternative views of picture naming that do not completely correspond to the three-stage framework described before. For example, some studies have suggested that a picture can be named without necessarily accessing its meaning. Evidence in this direction comes from experiments in which, under certain circumstances, access to a picture's name had an advantage over access to its meaning (Funnell, Hughes, & Woodcock, 2006, with children; Bredart, Brennen, Delchambre, McNeill, & Burton, 2005, using faces as stimuli), and from clinical studies in which patients were able to name pictures without apparent access to their meaning (e.g., Huddy, Schweinberger, Jentzsch, & Burton, 2003; Kremin, 1986; Ratcliff & Newcombe, 1982, using faces as stimuli; but see Riddoch, Humphreys, Coltheart, & Funnell, 1988, for an alternative explanation). On the other hand, Boucart and colleagues (Boucart & Humphreys, 1992, 1994; Boucart, Humphreys, & Lorenceau, 1995; Humphreys & Boucart, 1997) maintain that object recognition (i.e., access to its visual code) is not possible without the intervention of semantics. For example, Boucart et al. (1995; also Humphreys & Boucart, 1997) found a semantic influence in a picture–picture matching task. They conclude that access to the visual and semantic features of a picture occurs simultaneously or, at least, in cascade.

The first and second stages mentioned above (object recognition and semantic access) are of interest in the study of picture naming per se, but in the field of speech production the focus of interest is often on variables that take effect during the lexicalization of the picture's name (e.g., word length, word frequency, etc.). In order to study which variables constrain phonological retrieval in picture naming and how they do so, it is common practice to compare naming latencies (and accuracies) for sets of pictures that differ on some linguistic variable of interest (e.g., word length in Meyer, Roelofs, & Levelt, 2003; age-of-acquisition in Morrison & Ellis, 1995, and many others). The validity of the conclusions derived from such studies crucially depends on whether the stimuli are matched on all relevant variables (including nonlexical ones) other than the ones being manipulated; uncontrolled differences between picture sets in, for example, object recognition speed, or the time it takes to gain access to conceptual representations, may cause latency differences falsely attributed to the variable under investigation, or conversely, they could mask genuine underlying effects of the manipulated variable. Perhaps surprisingly, however, even relatively recently many studies have not included any control of nonlexical variables (as pointed out by Levelt, 2002).

Among the studies that have attempted to control for nonlexical variables in picture naming, a number of techniques have been used. For instance, in the episodic object recognition task (e.g., Bonin, Chalard, Méot, & Barry, 2006; Levelt et al., 1991), participants are first familiarized with a set of pictures, which are subsequently presented to them intermixed with a set of novel pictures. Their task is to classify all the items as "old" (i.e., present in the familiarization phase) or "new". Target pictures are typically in the "new" category in order to avoid priming effects; the idea is that latencies for these "new" responses reflect object recognition times. The principal claim underlying this method is that there is no access to the picture's name during the "old–new" decision process; however, this claim has not been empirically validated so far. Another issue that needs to be studied with respect to this task is whether it measures only visual characteristics of the object or whether it also includes semantic factors.

A different approach used as control task is to measure picture recognition response times directly. An example is the use of object/pseudo-object decision reaction times (Kroll & Potter, 1984; Levelt, Praamstra, Meyer, Helenius, & Salmelin, 1998; Meyer, Sleiderink, & Levelt, 1998), in a task that is the visual equivalent of lexical decision. However, it is often difficult to create pseudo-objects that are sufficiently confusable with real objects to ensure that participants do not base their decision on surface characteristics, and this may lead to difficulties in interpreting the findings. Indeed, characteristics of the pseudo-objects used in this task, and not just the target pictures, may affect reaction times in the same way that the nature of pseudowords affects lexical decision latencies to words.

A further control technique, and the focus of the present study, is the use of reaction times in a name–picture verification task, also known as name–picture matching.[1] A variation of this technique was introduced by Wingfield (1968) and has since been widely used in the literature (e.g., Bachoud-Lévi, Dupoux, Cohen, & Mehler, 1998; Jescheniak & Levelt, 1994; Levelt et al., 1991; Meyer, Belke, Hacker, & Mortensen, 2007; Özdemir, Roelofs, & Levelt, 2007; Santiago, MacKay, Palma, & Rho, 2000; Theios & Amrhein, 1989). In a name–picture verification task, participants are presented with a word for a relatively long period (typically 1,000 ms), followed by a picture. In some studies the word is presented aurally (e.g., Levelt et al., 1991) while in others visually (e.g., Jescheniak & Levelt, 1994). Once the picture appears, participants are to respond as quickly as possible whether the word matches the picture or not by pressing the appropriate key. The idea behind this procedure is that, given the long period of exposure, the word will have been encoded all the way through its semantic representation by the time the picture appears, so decision times for the task will be largely determined by the time it takes to recognize the picture. By matching across conditions on name–picture verification latencies or, alternatively, subtracting these response times (RTs) from picture-naming latencies (as done by, e.g., Santiago et al., 2000), nonlexical aspects of the recognition process are assumed to be factored out. Use of this method as a control task for picture naming is crucially based

[1] Name–picture verification in this context is similar but not identical to the technique used in neuropsychological studies to assess the integrity of the language-processing system (e.g., Psycholinguistic Assessment of Language Processing in Aphasia, PALPA, Subtest 47; Kay, Lesser, & Coltheart, 1992). In those studies there is no time constraint for the patient, and the dependent variable is usually accuracy, not reaction time. In the present study, on the other hand, we are interested in measuring latencies in a speeded task and in using these latencies as a control measure for picture recognition processes.

on the assumption that the decision on whether the picture matches the word does not involve access to the name of the picture.

To date relatively little evidence has been presented that would allow insight into how participants perform this task. Santiago et al. (2000) outlined three accounts of how name–picture verification is accomplished. According to an account that we label *"visual matching"*, when presented with the word, participants conjure up an image associated with the word's meaning and then compare this mental image with the picture presented later, based on their visual features. Since there is enough time for the word to be completely processed, reaction times would be mainly affected by visual/perceptual characteristics of the picture. According to an alternative account, which we may label *"conceptual matching"*, participants access the semantic content of the two elements in each trial (first for the word and subsequently for the picture) and compare them at the semantic level (see, e.g., Theios & Amrhein, 1989). Here, reaction times from the name–picture verification task should reflect the time it takes not only to perceive the picture (as in the first account), but additionally to access its meaning. In the third account, which we call *"lexical matching"*, the comparison is essentially based on covert naming of the picture: Participants access the lexical representation of its name via its meaning and compare it with the word.

It should be acknowledged that the three accounts and their associated predictions implicitly describe the picture processing as a staged process in which processing can terminate at specific stages depending on the relevant task. This assumption may be questioned, and indeed, as outlined above a number of empirical findings suggest cascadedness at the visual-semantic interface (e.g., Humphreys & Boucart, 1997). With regard to word–picture verification, distinguishing between visual and semantic processing stages is of less relevance. By contrast, the validity of this technique as a control task for studies of spoken production hinges on the assumption that it is not affected by lexical activity during the verification process. This would imply that it is in principle possible to process a picture without automatically activating its corresponding lexical label. Whether this is the case is at present unclear: Some recent studies (e.g., Meyer & Damian, 2007; Morsella & Miozzo, 2002) suggest that when target pictures are named, to-be-ignored distractor pictures are involuntarily phonologically encoded. Whether, by contrast, in tasks that do not involve overt spoken production, target picture processing entails phonological activation of its name is unclear, and it is one of the issues under investigation in the current study. However, some circumstantial evidence supports this claim. For example, Santiago et al. (2000) predicted that, if the name–picture verification task involved the retrieval of phonological codes, subtracting name–picture verification RTs from picture-naming latencies would eliminate the effects of lexical variables such as word length and onset complexity. On the contrary, they found significant differences in latencies between one- and two-syllable words and between simple and complex onsets even for these "corrected" latencies (picture-naming RTs minus match response RTs).

A further issue concerns whether to use responses from trials on which word and picture match, or those on which they mismatch. Past studies have typically used "match" responses as the variable of interest (e.g., Jescheniak & Levelt, 1994; Santiago et al., 2000) while "no-match" responses were treated as fillers. However, based on the assertion that presentation of the word may facilitate recognition of the subsequently presented target picture, Levelt (2002) strongly advocated the use of "no-match" responses. At the centre of Levelt's objection against the use of "match" responses is the possibility that genuine lexical effects in picture processing may be obscured by a ceiling effect caused by prior activation of the word. In this case, even under the "lexical matching" scenario outlined above, which assumes that word–picture matching is essentially based on covert naming of the picture, lexical properties associated with the target picture may not substantially affect response times. In fact, this argument may be extended to the two remaining theoretical accounts of word–picture verification outlined above: Visual and/or semantic preactivation from the word may prime processing of the target picture, therefore obscuring the influence of corresponding variables on response times. By contrast, "no-match" responses should not be affected by such facilitation, and hence visual, semantic, and/or lexical properties of the target picture may emerge in corresponding latencies. To date there exists little empirical evidence to justify the use of either "match" or "no-match" responses.

In summary, the name–picture verification task is widely used in studies on spoken production to control for nonlexical differences between picture sets. However, the processing mechanisms underlying this task have not been clearly identified to date, and hence the validity of studies using this control task may be questioned. In the present study we systematically explore the characteristics of this task by collecting reaction times for a large set of stimuli and assessing any contributors through a regression analysis on a subset of the pictures. It is our intention to provide further evidence that name–picture verification latencies are a good index of picture recognition without lexical intervention; specifically, we intend to determine the respective sensitivity of "match" versus "no-match" responses to visual, semantic, and lexical predictors. Additionally, despite the common use of this technique in the literature, each study so far has developed an ad hoc set of control scores. We endeavoured to produce norms of name–picture verification latencies for a large set of line drawings. We expect that the availability of such norms will encourage the use of this technique in future picture-naming studies. We chose to use as the basis for this study the 400 line drawings presented by Cycowicz, Friedman, Rothstein, and Snodgrass (1997), which include the 260 drawings from the well-known and often-used Snodgrass and Vanderwart (1980) set. This set of pictures has been widely used in speech production experiments and many other areas of research, and they have been normed for a variety of relevant factors in several languages. The experiment was run in Spanish but the resulting norms can be used in other languages, as the nonlexical variables that we are trying to match for are not language specific. We were able to evaluate the validity of the norms by performing a series of regression analyses on two partially overlapping subsets of these pictures, consisting of 223 and 137 items, respectively.

Method

Participants

A total of 100 psychology undergraduates from Universidad de Murcia, Spain, voluntarily took part in this experiment in exchange for extra academic credit. There were 83 female and 17 male participants with a mean age of 21.6 years (range = 18–51). They were all native Spanish speakers and had normal or corrected-to-normal vision.

Materials and design

Items for this task were taken from Cycowycz et al. (1997) and consisted of 396 black-and-white line drawings of common objects.[2] The 396 items were quasi-randomly assigned to List A or List B with the constraint that each list contained half of the Snodgrass and Vanderwart (1980) pictures and half of the additional pictures included in the Cycowycz et al. set. All participants were presented with all words, but for half of them words in List A corresponded to the "match" condition and words in List B to the "no-match" condition, and vice versa for the other half of participants. For no-match responses, pairings between words and pictures were assigned quasi-randomly for each participant so that the two items in the pair were not semantically related (e.g., we avoided pairing two animals or two items of clothing). The dependent variable was reaction times for the match/no-match decision between name and picture for correct answers.

[2] Three items from the original Cycowycz et al. (1997) set (*scoop*, *squash*, and *pretzel*) were excluded because of lack of an appropriate translation into Spanish. An additional item (*rosebud*) was also excluded because its translation is also used as a very rude word in Spanish.

Procedure

The experiment was carried out in a quiet and light-controlled room. Participants responded by pressing the letters "m" or "z" on the keyboard.[3] The key assignment to "match" or "no-match" was counterbalanced according to handedness, so that half of the participants gave "match" responses with their dominant hand and vice versa. Item presentation and data collection were controlled with E-Prime 1.1 (Schneider, Eschman, & Zuccolotto, 2002). All stimuli were presented in white over a black background. Words were presented in Courier New 18-point font, and pictures were sized to just fit into a square of 245 pixels per side. Each trial started with the presentation of a word for 1,000 ms, followed by a blank screen for 100 ms and then by the object. Participants were asked to respond whether the word and the drawing matched by pressing the corresponding key. If a response had not been entered after 1,500 ms, the trial was classified as a timeout, and the next trial was launched. The intertrial interval was 900 ms. Participants were encouraged to respond as quickly and as accurately as possible. The experimental trials were preceded by 16 practice items of the same style as the experimental ones (taken from Pérez & Navalón, 2003) in which participants received feedback on their reaction time and accuracy. The entire experimental session lasted approximately 30 minutes.

Results and discussion

Reaction times lying more than 2.5 standard deviations from an item's mean were excluded (2.2% of match and 2.8% of no-match responses). In total, removed data because of response errors, timeouts, or outliers corresponded to 7.1% for match and 6.2% for no-match responses. Among match responses, there were five items (*armadillo/armadillo, chisel/formón*, *llama/llama*, *ray/pez raya*, and *blimp/zepelin*) with error rates of 25% or more; these items were removed from all further analyses.

Table 1 presents a summary of the data collected for match and no-match responses; data for individual items can be downloaded in tab-delimited text format at: http://language.psy.bris.ac.uk/name-picture_verification.html

Reaction times for match responses were significantly faster than those for no-match responses, $t(390) = 6.20$, $p < .001$. Furthermore, the correlation between match and no-match latencies was unexpectedly low ($r = .31$, $p < .05$, with 396 items), which seems to suggest that different processes underlie the two types of response. This finding further motivates our intention to explore which of the two indexes should be used as a control for nonlexical factors in picture naming. The quicker response times found for match responses are consistent with other types of verification tasks in which it is widely accepted that "no" responses correspond to more complex processes than "yes" responses. For example, in lexical decision "no" responses are assumed to reflect some kind of aborted serial search (e.g., Grainger & Jacobs, 1996); "match" responses have also been shown to be faster than "no-match" responses in nonlinguistic contexts (Farell, 1985). The fact that no-match responses in the name–picture verification task are slower could be an indication of a further step in the decision process or an indication of a self-terminating search. The reader will note that the standard deviation (by items) for no-match responses is about half the size of that of match responses; this result is also consistent with the idea of a deadline response criterion for negative responses.

Participants' scores for match responses were considerably more reliable than those for no-match responses, with Cronbach's alpha coefficients (Cronbach, 1951) of .9 and .6, respectively. Applying George and Mallery's (2003) rule of thumb, match scores would be considered to have an "excellent" reliability, while the reliability of no-match responses would be considered "questionable". These results are relevant to our

[3] We used computer keyboards as input devices for our experiment, which are associated with a certain degree of measurement error due to infrequent polling of the device. Although this fact adds a small amount of error variance to latencies, we believe it is unlikely that this could have diminished the power of our experiment to reject the null hypothesis.

Table 1. *Summary data for the name–picture verification task*

	RT (ms)	*SD*	*%Error*
Match responses[a]	523	53.5	4.5
No-match responses[b]	542	27.7	3.5

Note: RT = response time.
[a]*N* = 391. [b]*N* = 396.

characterization of the scores because it cannot be expected that the correlation between each set of reaction times and predictor variables be higher than the correlation of an RT with itself. As is shown below, match latencies are indeed predicted much more accurately by the included variables than are no-match latencies.

Further analysis using regression

In a series of analyses we sought to identify the processing level at which this task resides. To this aim, we analysed reaction times with multiple regression analyses performed on subsets of the items. In choosing the predictors we followed previous regression studies on picture naming such as the one reported by Alario et al. (2004), using the following variables:

Rated visual complexity. This is a subjective estimate of how many lines and visual details are present in a drawing. In our study, values for visual complexity were taken from Sanfeliú and Fernandez (1996) who asked participants to rate the complexity of a particular picture, rather than the complexity of the object it represented, on a scale ranging from 1 (*very simple*) to 5 (*very complex*). According to Alario et al. (2004) this variable is clearly perceptual in nature.

Image agreement. This is a measure of the degree to which a given picture corresponds to the mental image elicited in a participant by the picture's name. Pictures with higher image agreement ratings are named faster (e.g., Barry, Morrison, & Ellis, 1997). Values were again taken from Sanfeliú and Fernandez (1996); in their study, participants heard the name of an object, were instructed to form a mental image, 3 s later saw the object itself, and rated the degree of agreement between the mental and the actual image (1 = low agreement; 5 = high agreement). According to Alario et al., image agreement is a perceptual variable.

Concept familiarity. This is an estimate of the degree of contact or familiarity with the object depicted in the drawing. We took our values from Sanfeliú and Fernandez (1996) who presented participants with objects and asked them to rate, on a scale ranging from 1 (*very unfamiliar*) to 5 (*very familiar*), the degree to which they came in contact with, or thought about, the depicted object. Concept familiarity has been shown to affect picture-naming latencies in a number of studies (e.g., Ellis & Morrison, 1998; Feyereisen, Van der Borght, & Seron, 1988; Snodgrass & Yuditsky, 1996). Hirsh and Funnell (1995) suggest that concept familiarity affects how someone accesses the semantic representation from a picture. In line with Alario et al.'s classification we characterize familiarity as a conceptual variable.

Age of acquisition (AoA). This is an estimate of the age at which a word was learned. There has been some controversy as to whether AoA is confounded with word frequency, but there is strong evidence that both make independent contributions to picture naming (e.g., Barry et al., 1997; Ellis & Morrison, 1998; Pérez, 2007; Snodgrass & Yuditsky, 1996). The attribution of AoA to a specific processing level is not as straightforward as with the other variables considered in this study. Some authors (e.g., Brysbaert, Van Wijnendaele, & De Deyne, 2000) have attributed a semantic locus to AoA, while for others (e.g., Brown & Watson, 1987) AoA is related to lexical factors, and yet for others (e.g., Izura & Ellis, 2004) these effects are located in the connections between semantic and lexical representations, while Moore, Smith-Spark, and Valentine (2004) also claimed that the locus of AoA effects is at least partially located at the perceptual input level. Brysbaert and Ghyselinck (2006) have also proposed that

AoA effects can be divided into two components, one that is dependent on word frequency and another one that is semantic in nature. Finally, it is possible that AoA reflect a loss of plasticity in cognitive systems capable of learning, with effects pervasive throughout (e.g., Ellis & Lambon Ralph, 2000).

AoA can be estimated by using subjective ratings (e.g., Cuetos, Ellis, & Alvarez, 1999; Stadthagen-Gonzalez & Davis, 2006) or objective measures where children of different ages are asked to name a series of pictures (e.g., Alvarez & Cuetos, 2007; Morrison, Chappell, & Ellis, 1997). The correlation between the two measures of AoA is quite high (Chalard, Bonin, Méot, Boyer, & Fayol, 2003; Morrison et al., 1997), although subjective AoA is typically intercorrelated with other predictors to a larger extent than is objective AoA (e.g., Chalard et al., 2003; Morrison et al., 1997; Pérez & Navalón, 2005) and hence provides a less pure measure. For our analyses reported below, values for objective AoA came from Alvarez and Cuetos (2007), who asked children of various age bands, ranging from 30 to 173 months, to name pictures and measured the accuracy of responses as an index of whether the corresponding object had been acquired. Values for subjective AoA were taken from Cuetos et al. (1999), who asked participants to estimate the age at which they believed they had learned a word, on a scale from 1–11, where 1 = before 2 years old, 2 = two years, old, 3 = three years old, and so on, up to 11 = 11 years or older.

Name agreement. This measure reflects how much agreement there is about the name of a picture. It is usually given as a percentage of participants within a sample that gave the target label as the name of a picture, as opposed to an alternative name (e.g., *pistol* vs. *gun*). In general, pictures with higher name agreement are named quicker (e.g., Barry et al., 1997; Lachman, Shaffer, & Hennrikus, 1974; Vitkovitch & Tyrrell, 1995). Values for our study were taken from Sanfeliú and Fernandez (1996), who asked participants to write down the first name that came to mind when presented with an object. According to Alario et al. (2004) name agreement is a lexical variable.

Word frequency. This is an objective frequency count that corresponds to an estimate of the number of times that a word has been encountered and is calculated by counting the number of times a given token appears in a representative corpus of written language. Word frequency consistently emerges as a significant contributor to reaction times in picture naming (e.g., Oldfield & Wingfield, 1965; see Alario et al., 2004). In order to reduce skew, we transformed all word frequency counts in the current study into a logarithmic scale using the formula log (1 + frequency). Values were taken from the LEXESP frequency count (Sebastián, Cuetos, Martí, & Carreiras, 2000). According to Alario et al. (2004) word frequency can clearly be characterized as a lexical variable.

Word length. This is a measure of the amount of phonological material to be encoded for a response. Word length is typically measured as the number of phonemes, or the number of syllables, of a given word. The role of word length in speech production has not been clearly established in the literature; some studies have found that it is a relevant factor (e.g., Klapp, Anderson, & Berrian, 1973; Meyer et al., 2003) while others have found no effect of length in factorial (e.g., Bachoud-Lévi et al., 1998) or regression studies (e.g., Alario et al., 2004). For the analyses reported below we used number of syllables as the variable of interest. Word length clearly is a lexical variable.

Regression I: 223 items

For the first analysis, we used a subset of 223 items[4] for which values for all seven predictors, including

[4] We only included items with monomorphemic picture labels and excluded items in which the modal label did not match the expected picture name.

objective estimates of AoA, were available. Table 2 presents a correlation matrix for the seven predictors and the two dependent variables (match RT and no-match RT). As is apparent, match RTs correlate significantly with all predictor variables except visual complexity and word length, whereas no-match RTs do not correlate significantly with any predictors, as would be expected given the low reliability exhibited by participants for these scores. Table 3 shows the results of the regression analyses. It is interesting to note that rated visual complexity affects neither match nor no-match responses. More interestingly, the other two clearly nonlexical variables (image agreement is a perceptual variable and concept familiarity a semantic one) significantly affect match responses. Name agreement and word frequency and length are not significant contributors to match latencies, whereas objective AoA is. As mentioned before, AoA likely has at least a partial component that is semantic in nature (e.g., Brysbaert & Ghyselinck, 2006), and for this reason the significant effect of AoA on match RTs is difficult to interpret regarding underlying processing levels. The analysis on match responses exhibits an R^2 of 23.7% ($p < .001$). In the regression on mismatch responses none of the predictors are significant, and the R^2 for the overall model is only 2.7% (*ns*). This indicates that factors other than the ones studied here mediate the "no" responses in the verification task.

Regression II: 137 items

In order to better understand the factors that affect name–picture verification, we performed a series of regression analyses on a subset of 137 items for which, in addition to the predictors mentioned before, we also had access to Spanish picture-naming latencies from Cuetos et al. (1999).[5] The predictors for these analyses were the same as the ones mentioned before.[6] However, because Cuetos et al. had originally used subjective AoA in their analysis, we likewise chose this measure in our initial analysis. Table 4 presents a correlation matrix for the eight predictors and the dependent variables.

We then analysed the three dependent variables (naming RTs, match RTs, and no-match RTs) with separate multiple regressions. Additionally, we formed so-called "corrected scores" for match and no-match responses. Corrected scores are obtained by subtracting, in turn, match and no-match latencies from picture-naming reaction times. Outcomes from this analysis allow us to test the assumption that picture naming and name–picture matching share some components but differ in others. Analysing these corrected scores allows us then to identify the nonshared components between picture naming and each of the two verification tasks (match and no-match) by highlighting which predictors are significant for the difference between them. Another way of looking at it (cf. Santiago et al., 2000) is that by subtracting name–picture verification latencies (which are supposed to contain all and only nonlexical variables involved in the recognition process) from picture-naming latencies, one should be left with the portion of the picture-naming task that is sensitive to the lexical variables involved. For match and/or no-match latencies to be deemed as adequate controls for nonlexical factors, one would expect that a regression on these corrected scores would show that *all and only the lexical predictors* are significant contributors.

A summary of results is presented in Table 5. The leftmost portion in the table reports regression results on naming RTs. The results essentially replicate Cuetos et al.'s (1999) results,

[5] The same criteria as those with the first set were applied for the selection of items used in the analysis. Additionally, "trompeta" (*trumpet*) was also excluded because of missing image agreement data.

[6] Note that Cuetos et al. (1999) used for their analyses different sources for concept familiarity and word frequency from the ones we used. They collected their own familiarity ratings, and their frequency values were taken from Alameda and Cuetos (1995), which are based on a smaller corpus than LEXESP. However, the general outcome of the analyses is the same irrespective of which of these sets of norms is used.

Table 2. *Correlation matrix for seven predictors with match and no-match response latencies for a subset of 223 items*

	RT							
	Match	*No-match*	*Visual complexity*	*Image agreement*	*Familiarity*	*Objective AoA*	*Name agreement*	*Log frequency*
No-match RT	**.19****							
Visual complexity	.10	−.03						
Image agreement	**−.29****	−.09	−.11					
Familiarity	**−.14****	.07	**−.45****	**−.17***				
Objective AoA	**.37****	.10	.06	−.08	−.08			
Name agreement	**−.32****	−.08	**−.17***	**.25****	**.13***	**−.51****		
Log frequency	**−.14****	−.05	**−.17***	**−.23****	**.44****	**−.31****	**.24****	
No. syllables	.06	.02	.13†	−.05	−.04	**.20****	**−.16***	**−.28****

Note: RT = response time. AoA = age of acquisition.
†$p < .10$. *$p < .05$. **$p < .01$.

with all predictors but visual complexity significant ($R^2 = .43$, $p < .01$). The next portion reports a regression on match RTs. Here the pattern of results is similar to the one obtained in Regression I ($R^2 = .23$, $p < .01$) in that the non-lexical variables image agreement and familiarity are significant. However, in contrast to Regression I, the variable AoA is not significant. For "corrected scores" for match responses (naming RTs minus match RTs), based on the logic outlined above we would expect a significant result for lexical predictors only. This is indeed the case, with name agreement, log frequency, and number of syllables (plus AoA) significant ($R^2 = .34$, $p < .01$). Further to the right, the regression on no-match RTs shows only a significant effect of AoA ($R^2 = .08$, *ns*). Finally, for the "corrected scores" for no-match responses we would predict a significant effect from predictors on all processing levels, and this is indeed the case for image agreement, familiarity, AoA, name agreement, log frequency, and number of syllables ($R^2 = .41$, $p < .01$).

Overall, the pattern of results implies that subtracting match reaction times factors out visual and semantic factors, but does not affect lexical variables, and it thus eliminates the "lexical matching" hypothesis as a possible explanation of how "yes" responses are generated. On the other hand, there is no clear pattern for no-match latencies:

Table 3. *Results of regression analyses for a subset of 223 items*

			Match RT			*No-match RT*		
Variable	*Mean*	*SD*	*β*	*SE*	*t*	*β*	*SE*	*t*
Visual complexity	2.69	0.94	−1.55	2.54	−0.61	−0.66	1.96	−0.34
Image agreement	3.68	0.69	−14.05	3.29	**−4.28****	−3.08	2.54	−1.21
Familiarity	3.15	1.12	−4.89	2.32	**−2.11***	1.80	1.80	1.00
Objective AoA	6.50	3.97	2.43	0.62	**3.91****	0.43	0.48	0.89
Name agreement	86.37	16.95	−0.19	0.15	−1.26	−0.03	0.11	−0.23
Log frequency	1.05	0.56	−2.67	4.60	−0.58	−3.69	3.56	−1.04
No. syllables	2.63	0.77	−1.55	2.85	−0.54	−0.57	2.21	−0.26

Note: RT = response time. Objective age of acquisition (AoA) is reported in years, name agreement in percentages, frequency in occurrence per million.
*$p < .05$. **$p < .01$.

Table 4. *Correlation matrix for eight predictors with naming latencies and match and no-match response latencies for a subset of 137 items*

	RT									
	Naming	*Match*	*No-match*	*Visual complexity*	*Image agreement*	*Familiarity*	*Subjective AoA*	*Objective AoA*	*Name agreement*	*Log frequency*
Match RT	**.339****									
No-match RT	**.219***	.060								
Visual complexity	.132	.052	.102							
Image agreement	−.110	**−.293****	−.019	−.123						
Familiarity	**−.470****	**−.316****	−.053	**−.341****	−.106					
Subjective AoA	**.521****	**.234****	**.232****	.105	.001	**−.581****				
Objective AoA	**.495****	**.257****	**.216****	−.010	−.084	**−.171***	**.498****			
Name agreement	**−.296****	**−.175***	−.090	−.003	**.225****	.068	**−.187***	**−.345****		
Log frequency	**−.421****	−.113	−.032	**−.191***	**−.206***	**.482****	**−.376****	−.166†	.108	
No. syllables	**.291****	.059	.066	.154†	.120	−.208*	**.208***	.063	.025	**−.295****

Note: RT = response time. AoA = age of acquisition. Naming latencies from Cuetos et al. (1999).
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$.

Only AoA is a significant predictor for these responses, and the model including all predictors is, once again, not significant. Also, all of the predictors (except rated visual complexity) make a significant contribution to the corrected no-match scores, as could have been predicted from the fact that most of the predictors included in the analyses were not significant contributors to no-match latencies (with the exception of AoA). With respect to the objectives of the present study, and based on the present data, it seems unwise to use no-match latencies to control for nonlexical factors involved in picture naming. It is not possible from (and falls outside the scope of) the present analysis to determine how no-match responses take place; however, as mentioned before, it is generally held in the literature that "no" responses in categorization tasks are more complex than "yes" responses (e.g., Grainger & Jacobs, 1996).

According to the results presented, we can also infer that there is some semantic intervention in the process that yields match responses, as evidenced by the significance of concept familiarity as a predictor of match latencies. This result rules out that match latencies are based only on visual characteristics of the picture, and it lends some support to the "conceptual matching" hypothesis (see Introduction) that postulates that the comparison between words and pictures takes place at the semantic level, with participants accessing the meanings of both the words and the pictures.

A curious finding is that AoA had a significant effect on match RTs in Regression I, but not in II. This could possibly be attributed to the fact that the item set was larger in the former than in the latter case, but also to our inclusion of objective AoA in the first analysis and subjective AoA in the second. To follow up on this finding, we repeated the regressions reported above while including objective, rather than subjective, AoA. The results are shown in Table 6. The regression on naming RTs renders similar results to those of the previous one ($R^2 = .49$, $p < .01$), except that the variable name agreement is no longer significant. Table 4 indicates that the correlation between objective AoA and name agreement is the highest among all variables (and substantially higher than that between subjective AoA and name agreement), and plausibly this collinearity causes the failure of name agreement to be significant when objective AoA is included. The regression on match RTs shows identical results to the one reported earlier, with the two nonlexical variables image agreement and familiarity significant ($R^2 = .25$, $p < .01$). Furthermore, the variable objective AoA is marginally significant.

Table 5. *Results of regression analyses for a subset of 137 items, with subjective AoA as a predictor*

	Naming RT			*Match RT*			*Naming RT − Match RT*			*No-match RT*			*Naming RT − no-match RT*		
	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*
Visual complexity	− 6.09	8.98	− 0.68	− 5.00	3.39	− 1.48	− 1.08	9.09	− 0.12	3.76	2.58	1.46	− 9.81	8.93	− 1.10
Image agreement	− 30.11	13.76	**− 2.19***	− 20.87	5.19	**− 4.02****	− 9.32	13.92	− 0.67	1.55	3.95	0.39	− 31.79	13.68	**− 2.32***
Familiarity	− 21.39	9.43	**− 2.27***	− 12.45	3.55	**− 3.50****	− 9.01	9.54	− 0.94	3.79	2.71	1.40	− 25.19	9.38	**− 2.69****
Subjective AoA	40.34	13.05	**3.09****	0.25	4.92	0.05	40.03	13.20	**3.03****	11.042	3.75	**2.95****	29.39	12.98	**2.26***
Name agreement	− 4.86	1.89	**− 2.57***	− 0.64	0.71	− 0.90	− 4.22	1.91	**− 2.21***	− 0.34	0.54	− 0.63	− 4.52	1.88	**− 2.40***
Log frequency	− 36.40	15.01	**− 2.42***	− 0.17	5.66	− 0.03	− 36.32	15.20	**− 2.39***	2.34	4.31	0.54	− 38.76	14.93	**− 2.60***
No. syllables	24.80	10.60	**2.34***	1.94	4.00	0.49	22.89	10.73	**2.13***	0.89	3.05	0.29	23.95	10.55	**2.27***

Note: RT = response time. AoA = age of acquisition.
*$p < .05$. **$p < .01$.

Table 6. *Results of regression analyses for a subset of 137 items, with objective AoA as a predictor*

	Naming RT			*Match RT*			*Naming RT − match RT*			*No−Match RT*			*Naming RT − no-match RT*		
	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*	β	*SE*	*t*
Visual complexity	− 6.54	8.42	− 0.78	− 4.48	3.31	− 1.35	− 2.04	8.76	− 0.23	3.14	2.59	1.21	− 9.65	8.43	− 1.14
Image agreement	− 30.16	12.96	**− 2.33***	− 20.31	5.10	**− 3.98****	− 9.92	13.48	− 0.74	1.00	3.99	0.25	− 31.30	12.98	**− 2.41***
Familiarity	− 31.32	7.72	**− 4.06****	− 11.82	3.04	**− 3.89****	− 19.55	8.03	**− 2.43***	0.42	2.38	0.18	− 31.78	7.73	**− 4.11****
Objective AoA	13.47	2.63	**5.12****	1.97	1.04	1.91†	11.49	2.74	**4.20****	1.89	0.81	**2.33***	11.58	2.63	**4.40****
Name agreement	− 2.77	1.86	− 1.49	− 0.21	0.73	− 0.29	− 2.56	1.93	− 1.32	− 0.16	0.57	− 0.29	− 2.61	1.86	− 1.40
Log frequency	− 36.38	14.13	**− 2.58***	0.59	5.56	0.11	− 37.07	14.69	**− 2.52***	1.62	4.35	0.37	− 38.04	14.14	**− 2.69****
No. syllables	26.46	9.96	**2.66****	1.67	3.92	0.43	24.82	10.36	**2.40***	1.62	3.06	0.53	24.90	9.97	**2.50***

Note: RT = response time. AoA = age of acquisition.
†$p < .10$. *$p < .05$. **$p < .01$.

However, compared to the original analysis, results from the corrected scores are somewhat less instructive: The variable name agreement, which is not significant in either the naming RT or the match RT regression, is not significant in the corrected score regression either. Moreover, the nonlexical variable familiarity, which according to our logic should not appear as significant in the corrected scores, is. In the regression on no-match RTs, we find the same pattern as that in the earlier regression—namely, only a significant effect of AoA ($R^2 = .06$, *ns*). Finally, in the corrected scores for no-match RTs all predictors are significant except visual complexity and name agreement ($R^2 = .47$, $p < .01$)

Overall, the results from Regressions I and II converge on the observation that match RTs are clearly affected by the two nonlexical variables image agreement and familiarity, but not by the lexical variables name agreement, frequency, and number of syllables. We interpret this pattern as indicating that, when participants perform a "match" response in a name–picture verification task, they apparently do so based on visual and/or conceptual, but not lexical, codes. The results regarding AoA are more complex, with objective AoA significant in Regression I and marginally significant in Regression II, but subjective AoA not significant. However, as stated above, effects of AoA are more complex to attribute unambiguously to a specific processing level. On the other hand, no-match RTs are generally unaffected by any of the predictors, with the exception of objective AoA in Regression II. This pattern leaves open what exactly participants base their no-match responses on. However, the results clearly suggest that lexical variables do not contribute to no-match RTs. As outlined in the Introduction, a possibility is that on match trials, the prior activation of the picture name yields a preactivation of lexical codes, which obscures the influence of lexical variables. However, in this case lexical predictors should have emerged significantly on no-match responses. The fact that they did not clearly refutes the "lexical matching" account of how participants perform name–picture verification. In turn this implies that the name–picture verification task can be used as a control task that captures prelexical variables.

Implications for models of lexical access

The main goal of the present research was to collect and validate normative data for a measure of nonlexical aspects of picture naming for a large set of items. In the process, we determined that "match" latencies from a name–picture verification task can indeed be used as an approximation to visual and semantic aspects of picture naming. Lexical variables by contrast do not appear to exert an influence on these responses, which may be taken as evidence against the possibility that the task is based on covert access to the picture's name (the "lexical matching" hypothesis). However, as outlined in the Introduction, this pattern—specifically, the absence of an influence of lexical predictors—may have come about as a result of facilitation arising from the word on "match" trials. This latter account can be discounted based on the absence of corresponding effects on "no-match" responses, which would have been predicted to emerge under this scenario. In fact, none of the variables used in the study except AoA showed an effect on "no-match" responses; hence we are unable to see how these could be utilized for matching nonlexical variables in picture-naming studies.

We characterized, for the first time in the literature, which variables mediate the name–picture verification task, which yields a clearer picture of when and how this technique could be used in psycholinguistic experiments and in conjunction with which other control variables. These norms can be used for studies conducted in languages other than Spanish since name–picture verification times are not sensitive to lexical factors, and as such their use as a control task is not restricted to the language in which the norms were collected. In fact, given that we are interested in avoiding the influence of any lexical factors in our control task, it would even seem desirable to use norms collected in a language different from the one used in the actual target experiment, as any potential remnant of a lexical component that could have affected response times should be scrambled.

We believe that the present set of norms will be of great use to researchers using this increasingly popular method of controlling for nonlexical aspects of word production, with applications in research into speech production, memory, and other fields of enquiry.

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