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Determinants of naming latencies, object comprehension times, and new norms for the Russian standardized set of the colorized version of the Snodgrass and Vanderwart pictures

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Abstract We report object-naming and object recognition times collected from Russian native speakers for the colorized version of the Snodgrass and Vanderwart (Journal of Experimental Psychology: Human Learning and Memory 6:174–215, 1980) pictures (Rossion & Pourtois, Perception 33:217–236, 2004). New norms for image variability, body–object interaction [BOI], and subjective frequency collected in Russian, as well as new name agreement scores for the colorized pictures in French, are also reported. In both object-naming and object comprehension times, the name agreement, image agreement, and age-of-acquisition variables made significant independent contributions. Objective word frequency was reliable in object-naming latencies only. The variables of image variability, BOI, and subjective frequency were not significant in either object naming or object comprehension. Finally, imageability was reliable in both tasks. The new norms and object-naming and object recognition times are provided as supplemental materials.

Keywords Object naming · Object recognition · Russian · Subjective frequency · Image variability · Body–object interaction (BOI)

Picture naming is a popular and experimentally tractable task that has been widely used to investigate both spoken (Griffin & Ferreira, 2006) and written (e.g., Bonin & Fayol, 2000; Bonin, Chalard, Méot, & Fayol, 2002; Roux & Bonin, 2012) word production. To use picture naming as a research tool, it is necessary that researchers have at their disposal (1) a pool of pictures and (2) information about different characteristics of the pictures (e.g., visual complexity), the depicted object (e.g., conceptual familiarity), and the picture name (e.g., frequency of use, age of acquisition [AoA]) in order to design appropriate controls. This requirement has led to the collection of norms for sets of pictures and their names. The Snodgrass and Vanderwart (1980; SV hereafter) database comprising 260 black-and-white drawings of objects was the first to be standardized in American-English. This set of pictures has been subsequently standardized in different cultures, language communities, and populations (e.g., Spanish, Sanfeliù & Fernandez, 1996; British English, Barry, Morrison, & Ellis, 1997; French, Alario & Ferrand, 1999; Italian, Nisi, Longoni, & Snodgrass, 2000; Japanese, Nishimoto, Miyawaki, Ueda, Une, & Takahashi, 2005; Chinese, Weekes, Shu, Hao, Liu, & Tan, 2007). A large number of studies have also recorded naming times (as well as naming accuracy scores) in different languages and populations (for a recent study, see Liu, Hao, Li, & Shu, 2011, in

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Mandarin Chinese) on the basis of this set of pictures. Picture databases other than the SV have also been normed (e.g., Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010) and have been used to collect naming times (e.g., Bonin, Peereman, Malardier, Méot, & Chalard, 2003). The different processes and representations that are involved in conceptually-driven naming have been delineated thanks to the collection of naming times for large set of pictures. It is generally assumed that object naming involves three main levels of processing: (1) *object comprehension*, which entails the perceptual analysis of the object, access to stored structural representations leading to the recognition of the object, and, finally, access to semantic information; (2) *name retrieval*, which, according to certain views of speech production (Levelt, Roelofs, & Meyer, 1999), is a two-stage process consisting of lexical selection and phonological encoding (that is to say, the activation of abstract lexical entries that are not phonologically specified; the so-called lemmas) and the selection of a lemma among the cohort of activated lemmas, followed by the phonological encoding of the selected lexical entry; and (3) *word articulation*, which requires the preparation of syllabic gestural scores and their motor execution by the articulators.

The psycholinguistics field has seen a steady increase in the number of studies that have used a multiple regression approach to identify the determinants of naming speed (and sometimes of naming accuracy) on the basis of the picture-naming task. It has been shown that this experimental task is affected by different factors that influence the various stages of the picture-naming process (Alario et al., 2004). As Alario et al. indicated in their review, the most important predictors of naming speed include name agreement and AoA of the picture name, followed by the frequency of the object name and, finally, image agreement. Several other predictors (e.g., imageability, conceptual familiarity, visual complexity) have been found to exert a reliable influence on naming speed, but in certain naming studies only (e.g., Bonin, Barry, Méot, & Chalard, 2004; Ellis & Morrison, 1998; Johnston, Dent, Humphreys, & Barry, 2010) and, therefore, in a less consistent manner.

The main goal of the present study was to obtain naming latencies and object comprehension times for the colorized SV pictures designed by Rossion and Pourtois (2004) and recently normed for the Russian language on name agreement, image agreement, conceptual familiarity, imageability, and AoA (Tsaparina, Bonin, & Méot, 2011). In addition, we collected three "new" (additional) psycholinguistic norms from the Tsaparina database (Tsaparina et al., 2011)—namely, image variability, body–object interaction (BOI), and subjective word frequency. We shall examine the reasons for collecting the latter norms after a brief summary of the main findings of the Tsaparina et al. study.

The picture database normed for the Russian language (Tsaparina et al., 2011) has the following characteristics. A large number of pictures present a high rate of agreement with the name (the mean percentage of name agreement is about 80 %). Despite this, the name agreement scores are lower and more variable than in other studies that have used the same colorized pictures (i.e., Dimitropoulo, Duñabeitia, Blitsas, & Carreiras, 2009; Rossion & Pourtois, 2004). In addition, the pictures generally give rise to high image agreement scores, and the concepts depicted by the pictures are mostly familar. Most of the modal object names are estimated as being learned at an early age and as having high imageability.

The colorized version of the SV pictures provided by Rossion and Pourtois (2004) have been normed in Modern Greek (Dimitropoulo et al., 2009), Belgian-French (Rossion & Pourtois, 2004), and Russian (Tsaparina et al., 2011). We acknowledge that it might have been interesting to use the original SV black-and-white drawings instead of the colorized version of these pictures, because this would have permitted a more extensive comparison of the cross-linguistic differences, since, as was mentioned above, the former set of pictures has been standardized in many more languages than has the latter. However, as was discussed in Tsaparina et al., the colorized version of the SV pictures has the advantage that both the speed and the accuracy of the naming performance are increased, as compared with the corresponding traditional SV black-and-white drawings (Rossion & Pourtois, 2004). It is worth mentioning that in recent years, several attempts have been made to provide alternative picture sets to the SV pictures, because the latter are thought to lack ecological value (Moreno-Martínez & Montoro, 2012). There is also a practical reason for our choice. Since the picture norms collected in Russian were obtained using the colorized version of the SV pictures, it seemed clear to us that we should also use these pictures in order to examine the influence of these variables in speeded naming reliably.

Why collecting image variability, BOI, and subjective frequency variables is important

The representation of object concepts in long-term memory and the recruitment of this knowledge during language comprehension have long been central topics in cognitive science (Amsel, Urbach, & Kutas, 2012). As far as language production is concerned, models of speech production have not systematically addressed the issue of how (and when) object knowledge influences the processes underpinning word production, which is understandable given their emphasis on post-conceptual psycholinguistic processes. Furthermore, we do not know precisely what type of object knowledge is recruited during the first step of object naming—that is, object comprehension. Indeed, most models of object naming propose that access to the word form of the name of a presented object necessarily requires semantic mediation. However, the functional separation between the object recognition and semantic systems is not always made explicit in models of spoken word production (e.g., Caramazza, 1997), and some models appear to suggest that the functions of object recognition and comprehension are positioned within a common conceptual level (e.g., Levelt et al., 1999). However, the distinction between object recognition and semantics is an important one (e.g., Bonin, Roux, Barry, & Canell, 2012; Coltheart, 2004). To investigate the issue of the kind of object knowledge that is mobilized in object naming (and possibly to further determine how it influences speech production), norms relating to object knowledge are required. In the present study, we therefore collected image variability and BOI norms. The details concerning the collection of the image variability and BOI norms are provided in the "Procedure" section. Beyond object naming, these image variability and BOI norms will also be useful to researchers who wish to investigate similar issues in word recognition.

According to Bennett, Burnett, Siakaluk, and Pexman (2011), sensorimotor knowledge influences linguistic conceptual processing. The BOI variable, which is one of the new norms collected here, assesses the ease with which a human body can physically interact with a word's referent. Several studies have provided evidence of facilitation effects on words that refer to things with which a human body can easily interact (e.g., *mask*), as compared with words referring to things that cannot easily interact with the body (e.g., *ship*) in tasks such as lexical decision, phonological lexical decision, or insult detection (e.g., Siakaluk, Pexman, Aguilera, Owen, & Sears, 2008; Wellsby, Siakaluk, Pexman, & Owen, 2010). One hypothesis proposed in order to account for these findings is that conceptual processing occurs through the simulation of the neural states that are engaged during bodily interaction with the environment. Imageability and BOI effects in lexical processing have been explained in terms of the theory of perceptual symbol systems. According to this theory, words that refer to things that are associated with a high level of sensory experience (e.g., high-imageability words, words associated with many different mental images) will develop richer sensory representations than will words that refer to things that do not permit a great deal of sensory experience (e.g., low-imageability words, words associated with few different mental images). Similarly, as far as the influence of BOI is concerned, words that refer to things with which a human body can easily interact (e.g., *mask*) will develop richer motor representations than will words that refer to things that cannot easily be interacted with (e.g., *ship*). Richer representations, whether sensory or motor, will elicit richer simulations (Bennett et al., 2011). BOI has been found to make a reliable contribution to picture-naming latencies (Bennett et al., 2011), and its influence is ascribed to the semantic level involved in picture naming.

Snodgrass and Vanderwart (1980) introduced the image variability variable. To collect image variability ratings, participants are asked "whether the name (of an object) evokes few or many different images for that particular object." Snodgrass and Vanderwart predicted that if a participant was able to generate many different mental images for a given concept, the picture chosen to represent it would be less likely to match any one of his or her mental images. A negative correlation between the image agreement and image variability measures was anticipated and, indeed, found in their study (as well as in Bonin et al.'s [2002] study). One hypothesis is that the locus of image variability lies at the level of structural representations. If it is assumed that objects that evoke many different mental images (e.g., *bird*, *car*) are less likely to match any of the stored mental images in the "lexicon of visual object forms" (Coltheart, 2004), then the time taken to complete the matching process should be longer for objects with high image variability ratings. However, contrary to this hypothesis, Bonin et al. (2002) found a reliable negative contribution of image variability in object-naming times. Thus, image variability is considered to impact the semantic level. Like the BOI variable, it is assumed that object names with high image variability scores have richer representations than do names with low image variability scores, with the result that the activation of semantic codes is stronger for object concepts that are richer, due to the fact that they possess more mental images, than for object concepts that possess a few or only a single mental image. It is worth pointing out, however, that most picture-naming studies have not examined the influence of this variable.

To summarize, words with high imageability, image variability, and BOI ratings are thought to have richer sensory and/or motor representations than do those with lower ratings on these dimensions. Since the image variability and BOI variables are clearly related to the object comprehension level involved in both picture naming and name–object verification tasks, we predicted reliable contributions of these variables in both tasks. However, to date, the influence of these norms in either object naming or object comprehension has not been examined to the same extent as in the case of name agreement, AoA, or objective word frequency.

Finally, we also collected subjective frequency norms. Subjective frequency has long been thought to be a better index of the frequency of encounter of words than has objective word frequency, especially for objective low-frequency words (Gernsbacher, 1984). However, a more recent work (e.g., Brysbaert & Cortese, 2011) has shown that the usefulness of subjective frequency ratings is likely to depend on the quality of the objective word frequency counts, and this has led certain researchers to claim that subjective frequency ratings are no longer needed, as long as good objective word frequency counts are available (Brysbaert & Cortese, 2011; Brysbaert et al., 2011). Subjective frequency in timed picture-naming studies has not often been investigated. Liu et al. (2011) introduced subjective frequency in a multiple regression analysis of naming latencies on drawings of objects in Mandarin Chinese, alongside other important variables such as conceptual familiarity, image agreement, rated AoA, and so forth but did not find a reliable contribution of this variable. However, in their study, objective word frequency was not introduced as a predictor in the different regression analyses. As far as the Russian language is concerned, following the work of Brysbaert and Cortese, we thought it important to identify the weight of subjective frequency, as compared with objective word frequency. Thus, using picture-naming latencies, we examined the extent to which the subjective frequency norms add specific information or correct (potentially) poor objective word frequency measurements. Finally, subjective word frequency norms will be useful to researchers investigating word recognition and memory processes.

Identifying the determinants of object comprehension

As compared with object naming, less research has been devoted to the identification of the determinants of *object comprehension*. As has already been stated, object comprehension is a specific and important component of object naming (Bonin et al., 2012). Levelt (2002) identified three tasks that can be used to assess effects operating at the level of object comprehension: (1) the object decision task (introduced by Kroll & Potter, 1984), (2) the object recognition task, and (3) the name–picture verification task. In the object decision task, participants have to judge whether a presented pictures is a real object or a nonobject. A potential drawback of this task is that, since object decision times are sometimes as long as picture-naming latencies, it can be argued that it does not exclusively index object comprehension. The object recognition task is a memory task. Individuals first have to learn a set of nontarget pictures. These pictures are then intermixed with a set of experimental pictures, and participants have to respond "old" to the "seen" pictures and "new" to the "unseen" pictures. Finally, in the name–picture verification task, participants are first presented with a word, followed by a picture. They have to indicate whether the two stimuli match by pressing an appropriate response ("same'" or "different"). In the present study, we collected object comprehension times for the colorized pictures of the SV database from Russian adults by means of the name–picture verification task. The object comprehension tasks described above have already been employed in psycholinguistic studies of spoken word production, where they have primarily been used as control tasks to test whether certain effects attributed to the name retrieval level are genuine lexical effects or can be attributed (at least in part) to the object comprehension level (e.g., word frequency effects in Jescheniak & Levelt, 1994; semantic interference effects in Schriefers, Meyer, & Levelt, 1990). Indeed, the name–picture verification task has often been used in spoken picture-naming studies as a control task thought to be suitable for controlling nonlexical differences between picture sets (Bonin, Chalard, Méot, & Barry, 2006; Stadthagen-Gonzalez, Damian, Pérez, Bowers, & Marín, 2009). Levelt claimed that *nonmatch responses*, but not *match responses*, should be included in the analyses in this task because the latter are contaminated by priming effects. However, contrary to this claim, Stadthagen-Gonzalez et al. recommended that matched, but not nonmatched responses, should be taken into account (and we follow this advice in our present study). In effect, using regression analyses in which they explored the characteristics of this task by assessing the independent contribution of a series of factors that have been found to be relevant for picture naming, they found that no clear pattern emerged from the analysis of nonmatched responses. In contrast, for the matched responses, both visual and conceptual factors played a role, but lexical variables were not significant contributors. More precisely, Stadthagen-Gonzalez et al. found that the two nonlexical variables *image agreement* and *conceptual familiarity* were reliable predictors of matched verification times, whereas the variables *name agreement*, *word frequency*, and *number of syllables* were not. In the earlier study of Bonin et al. (2006), using the same task, the same pattern of findings was obtained. Imageability, name agreement, and image agreement all had significant effects on the verification times of matched responses, whereas only image agreement was reliable on nonmatched responses.

Why is it important to collect naming and object comprehension times?

As was outlined above, normative studies of timed picture naming are important because they contribute to a better understanding of the dynamics of spoken (but also written; see Bonin et al., 2002) word production. Thus, the collection of naming times and object comprehension times from normed pictures not only is important for theoretical reasons, but also is critical with regard to methodological issues.

At the theoretical level, the identification of the determinants of both naming and object comprehension is important because it has helped us discriminate better between the processes and representations that are common to both skills and those that are specific. When different sets of pictures are used in different studies to investigate a specific component of a given cognitive skill, it is sometimes difficult to isolate the influence of a set of specific variables on this component from other idiosyncrasic aspects of the pictures used in the studies. In effect, researchers have adopted the following line of reasoning. Given that the same processes and representations are involved in both activities, the same predictors of processing speed (or accuracy) should be reliable. Identifying determinants specific to one of them would help to identify the nonshared processes. This strategy was clearly implemented by Bonin et al. (2006; see also Bonin & Fayol, 2000). Bonin et al. (2006) addressed the issue of whether AoA effects or word frequency effects on naming performance may be partly or entirely due to visual object comprehension processes by determining the extent to which the variables that have generally been found to affect picture-naming times also affected object comprehension times. To this end, they used 203 pictures taken from the Snodgrass and Vanderwart (1980) database as *no-response* stimuli (i.e., stimuli that should be identified as “different”) and 203 pictures taken from the larger Bonin, Peereman, et al. (2003) database as *yes-response* stimuli (i.e., to be identified as “same”). The authors found that imageability, name agreement, and image agreement were reliable predictors of name–object verification times for the *same* responses, whereas the only variable that made a reliable contribution to verification times for the *different* responses was image agreement. Thus, AoA and word frequency could not be attributed to the object comprehension level involved in object naming.

At the methodological level, when picture sets that correspond to the dimensions of interest to the experimenter are selected—for instance, high- and low-frequency picture names—care must be taken that the two picture sets are controlled for factors that relate to the comprehension level involved in object naming, such as, for instance, the visual complexity of the pictorial stimuli or the conceptual familiarity of the object. This, in essence, is Levelt’s (2002) main criticism of certain picture-naming studies (e.g., Barry, Hirsh, Johnston, & Williams, Barry et al. 2001; Bonin, Fayol, & Chalard, 2001). Levelt was vigorous in claiming that before one can conclude that a factor affects name retrieval in object naming, it is necessary to make sure that it does not affect the object comprehension stage. One way to control for these aspects is to use pictures that differ on word frequency but are controlled for at the level of ease of object comprehension (see Bonin et al., 2006, for this type of control). This information can easily be obtained when object comprehension times are available for a large set of pictures. Our study will make it possible to provide this information to researchers for the colorized version of the SV pictures.

Predictions examined in the present study

As far as the determinants of naming latencies of the SV colorized pictures are concerned, we are aware of only two studies that have collected naming times: one in French (Rossion & Pourtois, 2004) and one in Chinese (Weekes et al., 2007). Weekes et al. found a high correlation (.85) between naming times with line drawings and colored pictures. The authors also found that the main determinants of naming speed were name agreement, familiarity, and AoA. However, they noted a reduced effect of image agreement on naming times when colored pictures were presented, thus suggesting that the object comprehension level in object naming is facilitated when colored pictures are used. We expected to find the same result in the present study. Given that most timed picture-naming studies have found strong effects of name agreement, AoA, and word frequency in object naming (Alario et al., 2004), we expected these variables to contribute to object-naming times. The findings are less straightforward in object comprehension, since effects of name agreement were found, for instance, in the Bonin et al. (2006) study, but not in that conducted by Stadthagen-Gonzalez et al. (2009). However, neither of these two studies found a reliable contribution of word frequency, whereas they did identify a reliable effect of image agreement, as well as of semantic variables such as imageability or conceptual familiarity, on name–object verification times. Furthermore, we examined the relations that exist among the different variables, the naming and object comprehension times, and the new collected norms. Several multiple regression analyses were performed on both naming latencies and name–object verification times. We focused in particular on the role played by the new collected norms in these two tasks. Furthermore, the results collected in this study were then also compared with those reported in previous investigations.

Method

Participants

A total of 210 Russian native speakers (165 females and 45 males; mean age: 31.5), all right-handed and with normal or corrected-to-normal vision, took part. Most of them were students from Saint-Petersburg State Pediatric Medical Academy, or Saint-Petersburg State University or staff members from the Sechenov

Institute of Evolutionary Physiology and Biochemistry. There were 29 people in the timed picture-naming task, 38 in the image variability rating task, 36 in the subjective frequency rating task, 47 in the BOI rating task, and 60 in the object recognition task.[1] All the participants were volunteers.

Stimuli

We used the 260 colorized images of the corresponding Snodgrass and Vanderwart (1980) drawings that were created by Rossion and Pourtois (2004) and are available for free download at http://www.nefy.ucl.ac.be/facecatlab/stimuli.htm.

Procedure

For both object naming and name–object verification, a Macintosh computer running the PsyScope software (Cohen, MacWhinney, Flatt, & Provost, 1993) was used. The computer controlled the presentation of the pictures and recorded the latencies (object naming) or the RTs (object comprehension). For the naming task, the participants wore headphones with a sensitive built-in microphone (adjusted to the optimal distance from the participant's mouth) that was connected to a button-box used to record the spoken latencies. For object comprehension, two keys on the computer keyboard were used.

Object naming

The participants performed the object-naming task individually in a soundproof room. They had to speak aloud, as quickly as possible, the name of any given picture presented centered on the screen (at a distance of about 60 cm). They were required to avoid making any noise before the response ("um" or mouth clicks). Whenever they did not know the name of the picture, they had to state whether they did not recognize the object (DKO), they did not know the name of the object (DKN), or they were in a *tip of the tongue* (TOT) state. The experimenter monitored the participants' responses and scored them for correctness. An experimental trial was as follows. An asterisk was presented on the screen for 200 ms and was then followed 500 ms later by the picture. The next trial started 3,000 ms after the participants initiated their naming response. Short breaks were given every 50 trials. We used ten pictures as warm-ups and also to adjust the microphone settings. The experimental sessions lasted 45 min on average.

Name–object verification

As in the case of object naming, the participants performed the task individually in a soundproof room. They were told that they would first see a written name followed by a picture, both of them centered on the screen. For any given picture, they had to respond as quickly as possible whether the picture represented the same object as the written name or a different object. The *same* response was assigned to the "M" key of the dominant hand, and the *different* response to the "Q" key. The structure of a trial was as follows. A ready signal ("*") was presented on the screen for 500 ms. This was immediately followed by a word that was presented in lowercase (48-point, Chicago font) for 1,000 ms and then by a picture that remained on the screen until a key was pressed. The next trial began 3,000 ms after the participant's *same* or *different* response. There were short breaks after every 50 trials. Ten pictures were used at the beginning of the experiment as warm-ups.

Rating tasks

In the subjective frequency, BOI, and image variability tasks, the ratings were produced on the basis of the written modal names. A booklet containing all the modal names was prepared.

As far as the subjective frequency rating task is concerned, a 7-point scale was used, following the procedure used by Balota, Pilotti, and Cortese (2001). The instructions given to the participants were similar to those used by Balota et al. and recently employed in the French study of Ferrand et al. (2008). Participants had to assess the frequency of encounter of the words in their written or spoken form. They assigned their ratings (by putting a cross) using a 7-point scale with 1 = *never*, 2 = *once a year*, 3 = *once a month*, 4 = *once a week*, 5 = *every 2 days*, 6 = *once a day*, and 7 = *several times a day.*

In the BOI task, the instructions provided by Bennett et al. (2011) were closely adhered to. The participants had to rate the words on a scale of 1 to 7 by indicating the ease with which a human body can physically interact with the object represented by each of them. A value of 1 was used to indicate a *low body–object interaction* rating, and a value of 7 a *high body–object interaction* rating. The values of 2 to 6 indicated intermediate ratings. Given that this task has not as yet been used very frequently in psycholinguistics, these instructions are reported in full in Appendix A of the Supplemental Materials.

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[1] The reason why there were 60 participants in the object recognition task, as compared with the 29 in object naming, is because (1) half of the pictures were paired with a positive yes-response and the remaining half with a negative no-response and (2) any given participant was exposed to only half of the material with a given response type. Because only the positive trials were of interest here, in order to obtain the same number of observations for each item as in object naming, we had to recruit twice the number of participants as in object naming.

The image variability task has already been used to rate the modal names of objects in previous picture-norming studies (e.g., Alario & Ferrand, 1999; Bonin, Peereman, et al., 2003). In the image variability task, the participants were instructed to rate on a 5-point scale whether the name evoked few or many different images for that particular object (1, *few*; 5, *many*).

Results

In this section, we will first present reliability scores for the subjective frequency, image variability, and BOI norms and correlational analyses with other psycholinguistic variables. Then we will describe how the naming and object recognition times were scored. Finally, the multiple regression analyses on (1) object-naming times and (2) object recognition times will be reported. The image variability, BOI, and subjective frequency norms, together with the naming and object recognition times, are provided in Appendix B of the Supplemental Materials.

Reliability of the subjective frequency, image variability, and BOI norms and correlational analyses with other psycholinguistic variables

Table 1 shows the correlation (*r*) between even and odd participants and the intraclass correlation coefficients [random effects of both participants and items; ICC(2, *k*) following Shrout & Fleiss's (1979) terminology]. The reliabilities of the norms are high and nearly identical.

Table 2 shows the correlation coefficients between the present norms and those obtained for (1) subjective frequency in Chinese (Liu et al., 2011), in American English (Balota et al., 2001), and in French (Bonin, Méot, et al., 2003); (2) image variability in Chinese (Liu et al., 2011), in French (Alario & Ferrand, 1999), and in Spanish (Sanfeliu & Fernandez, 1996); and (3) BOI for Canadian English (Tillotson, Siakaluk, & Pexman, 2008). Given that these norms were all developed for different purposes, they were not computed using the same items. With the exception of image variability, for which the correlations with Chinese and Spanish ratings were around .50, the other values were over .70, thus establishing that the present norms are reliable.

Table 1 Correlation (*r*) between even and odd participants and intraclass correlation coefficients (ICCs)

	r(even, odd)	ICC
SubjFreq	.97	.97
Ivar	.98	.89
BOI	.96	.98

Note. SubjFreq = subjective frequency; Ivar = image variability; BOI = body–object interaction

Table 2 Correlations between subjective frequency, image variability, and body–object interaction (BOI) collected in the present study and other studies

	Chinese	English	French	Spanish
SubjFreq	.78 (220)	.71 (118)	.81 (253)	
Ivar	.45 (220)		.76 (259)	.59 (245)
BOI		.76 (99)		

Note. SubjFreq = subjective frequency; Ivar = image variability. American English for subjective frequency and Canadian English for BOI. The numbers of items used to compute the correlations are provided in brackets.

As far as the newly collected variables are concerned, the means for both image variability and subjective frequency correspond nearly to the centers of the scales (Table 3). Moreover, the distributions of these measures are symmetrical (or have a slightly positive skew). In contrast, the BOI scores have a relatively higher mean and a more marked negative skew, which indicates that most of the objects evoked by the words were judged to be easy to physically interact with.

As is shown in Table 4, subjective frequency, imageability, conceptual familiarity, and BOI constitute a set of highly and positively interrelated variables. Positive correlations of these variables with image variability were also observed, with somewhat lower values—in particular, for BOI. As far as AoA is concerned, the same pattern was found, but with opposite signs. Name agreement was the variable most strongly correlated with image agreement. Despite the large number of items that were rated (230 items), the correlations of the "agreement" variables with the other norms were relatively low. Indeed, the significance level of .001 was reached only with AoA and with imageability for the two name agreement measures and with image variability (for the percentage name agreement).

Scoring of the naming and object recognition times

As far as the picture-naming task is concerned, items that had an error rate greater than 50 % were removed from the analyses.[2] For the remaining items (230), trials were eliminated as follows. Trials for which alternative names (synonyms or other names: 5.32 %) or phonological/morphological variants (3.75 %) were produced were discarded. Trials involving *I don't know* (0.18 %) and TOT responses (0.16 %), or during which technical problems (with the voice key) occurred were

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[2] We chose this cutoff point in line with previous studies of object naming (e.g., Bonin et al., 2002; Bonin, Peereman, et al., 2003).

Table 3 Statistical characteristics of the collected variables

Variable	Code	*N*	Mean	*SD*	Asym	Min.	Max.
Naming latency	NamLat	230	887.71	92.14	0.38	696	1134
Object comprehension time	ObjRT	260	617.65	56.18	1.15	498.64	895.24
Name agreement*	NA	260	80.63	19.64	−1.06	17.39	100.00
Image agreement*	IA	260	4.34	.36	−1.60	2.41	4.97
Conceptual familiarity*	Fam	260	3.80	.78	−039	1.61	4.92
Rated AoA*	AoA	260	1.93	.56	1.31	1.19	4.29
Imageability*	Imag	260	4.45	.47	−1.93	1.71	4.97
Objective visual complexity*	VC	260	41.62	18.10	3.36	11	212
Objective word frequency (Log)**	ObjFreq	250	2.76	1.35	0.43	0.22	6.88
Subjective word frequency	SubjFreq	260	4.01	1.26	0.40	1.53	6.81
Image variability	Ivar	260	3.04	0.61	−0.01	1.53	4.50
Body–object interaction	BOI	260	4.98	1.69	−0.81	1.21	6.91
Number of phonemes	Phon	248	5.77	1.62	0.61	3	11

Note. NA = percentages of participants who provided the modal name

*Taken from Tsaparina, Bonin, and Méot (2011)

**From Lyashevskaya and Sharov (2008)

set apart (1.39 %). In addition, trials with a latency below 400 ms (28 trials) and those with a latency above 2,000 ms (80 trials) were set apart (overall: 1.62 %). Finally, latencies more than 2.5 standard deviations above or below the participant and item means were excluded (3.7 % of the data). Overall 15.8 % of the RTs were discarded from the 230 retained items.

In the name–object verification task, errors occurred on 203 trials (2.6 %).[3] Among the remaining trials, those with a latency below 200 ms (24 trials) or above 1,800 ms (39 trials) were set apart (overall: 0.8 %). Finally, RTs more than 2.5 standard deviations above or below the participant and item means were excluded (2.9 % of the data). Overall, out of the 260 items, 6.3 % of the RTs were discarded.

Multiple regression analyses on object-naming times

Hierarchical regression analyses were conducted with naming latencies as the dependent variable. Three sets of independent variables (IVs) were successively studied. The first set comprised the articulatory binary coded features of the initial phonemes of the object names. The second set included name agreement (%NA) and image agreement, objective word frequency (log transformed), AoA, objective visual complexity, and word length (in terms of number of phonemes). The third set comprised conceptual familiarity, subjective frequency, imageability, BOI, and image variability.

As in the Bennet et al. (2011) study, we included initial phonemes in the first set. These features are very important to control for in the subsequent sets because this reduces the unexplained variance and makes the tests more powerful. The second set was made up of IVs (1) that do not depend on the participant's performance (i.e., objective word frequency, visual complexity, and length) or (2) for which reliable effects have been repeatedly found in object naming (i.e., name and image agreement, AoA) and which, therefore, always have to be controlled for when investigating other (less often studied) IVs. The variables making up the third set were chosen because of the high correlations found between them and certain IVs of the second set (see Table 4). This holds particularly true for the imageability and image variability variables, which are assumed to index semantic codes. As far as subjective frequency is concerned, this was highly correlated with objective word frequency, while conceptual familiarity was strongly linked with these two variables.

The results of the hierarchical regression analyses conducted on the basis of these two sets are summarized in Table 5. First of all, in set 1, the amount of variance accounted for by the phonological onset variables collectively was 11 %. Second, in set 2, the most important reliable predictors were name agreement, image agreement, and AoA. Objective word frequency was also reliable, but its beta weight was lower. Set 3 comprised the remaining variables: conceptual familiarity, subjective frequency, imageability, BOI, and image variability. As was noted above, there were high-bivariate correlations between the

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[3] Since the responses in the name–object verification task were of only two types (either "yes" or "no" responses), the task was relatively easy, and there were therefore very few errors. The 2.6 % outcome was computed as follows. There was 203 errors (a "yes" response to a negative trial or the reverse) out of 7,800 trials, where 7,800 comes from two different groups of 30 participants who were presented with half of the items (130)—that is, 2 * 30 * 130 = 7,800 trials.

Table 4 Correlations among the measures

	ObjRT	NA(%)	NA(H)	IA	Fam	AoA	Imag	VC	ObjFreq	SubjFreq	Ivar	BOI	Phon
NamLat.	.42**	−.44***	.48***	−.32***	−.37***	.43***	−.42***	.00	−.32***	−.36***	−.34***	−.21**	.10
ObjRT		−.51***	.51***	−.41***	−.18**	.44***	−.32***	−.01	−.13*	−.19**	−.27***	−.08	.03
NA(%)			−.96***	.49***	.13*	−.37***	.25***	−.02	.09	.12*	.20***	−.04	−.07
NA(H)				−.55***	−.15*	.37***	−.27***	.02	−.07	−.13*	−.19**	.02	.06
IA					.08	−.17**	.19**	−.15*	−.01	−.01	−.09	−.02	.01
Fam						−.58***	.82***	−.09	.46***	.88***	.58***	.70***	−.06
AoA							−.60***	−.14*	−.47***	−.54***	−.66***	−.17**	.27***
Imag								−.08	.41***	.70***	.62***	.66***	−.05
VC									.00	−.06	.03	−.17**	−.05
ObjFreq										.59***	.63***	.18**	−.27***
SubjFreq											.63***	.62***	−.10
Ivar												.36***	−.19**
BOI													.04

Note. The names of the variables corresponding to the codes are provided in Table 3. In the picture-naming task, correlations were computed using the 230 retained words. Frequency scores were available for 224 of them. Russian names comprising two words (12 items) were not used for the computations of the correlations with frequency and phoneme length. NA-H = *h* measure for name agreement. The scores of NA, IA, Fam, AoA, Imag, VC were from Tsaparina, Bonin, and Méot (2011); ObjFreq from Lyashevskaya and Sharov (2008)

$^{*}p \leq .05$

$^{**}p \leq .01$

$^{***}p \leq .001$

Table 5 Summary of the different multiple regression analyses using three sets (set 1, set 2 and set 3) of independent variables (IVs) in object naming and object recognition

	Object naming	Object recognition
Set 1	$R^2 = .114$	Not included
Set 1 + set 2	$R^2 = .437$	Set 2 $R^2 = .376$
Set 2 IVs		
NA	−.281***	−.296***
IA	−.229***	−.193**
AoA	.251***	.339***
VC	.041	−.01
ObjFreq	−.192**	.027
Phon	−.033	−.073
Set 1 + set 2 + set 3, Imty	$R^2 = .466$	
NA	−.268***	
IA	−.234***	
AoA	.156*	
VC	.004	
ObjFreq	−.152*	
Phon	.004	
Imag	−.207***	

Note. The names of the variables corresponding to the codes are provided in Table 3; the scores of NA, IA, Fam, AoA, Imag, VC were from Tsaparina, Bonin, and Méot (2011); ObjFreq from Lyashevskaya and Sharov (2008)

$^{*}p \leq .05$

$^{**}p \leq .01$

$^{***}p \leq .001$

variables in the latter set. This led us to anticipate potential difficulties in the interpretation of the results of the multiple regression analyses due to colinearity problems. We therefore examined the coefficients of determination between (1) the variables of this set and (2) all the variables. These analyses (see Table 6) confirmed that the inclusion of all the variables simultaneously in the regression equation might have been problematic.

Given the results of the analyses on the coefficients of determination, a forward procedure was used for the following steps of the regression analyses. In the first step, we examined the variables that reached significance when they were included alone over that of the two first sets of variables. This procedure was then repeated for the remaining variables. The results of this procedure were as follows. All the variables of the third set (familiarity, subjective frequency,

Table 6 Coefficients of determination between independent variables (IVs; columns) and (1) only the variables of their set (set 3) and (2) all the variables

	Fam	SubjFreq	Imag	Ivar	BOI
1	.870	.800	.742	.446	.574
2	.891	.834	.777	.668	.711

Note. The names of the variables corresponding to the codes are provided in Table 3; 1 = R^2 between each IV of the third set and the other IVs of this set; 2 = R^2 between all IVs; the scores of Fam and Imag were taken from Tsaparina, Bonin, Méot (2011) imageability, and BOI) except image variability reached significance in the first step. The most important change in $R^2$was for the imageability variable. In the second step, imageability was the only variable that remained significant after any other variable (i.e., familiarity, subjective frequency, etc.) had been entered into the equation during the first step. However, whenever imageability was entered in the regression equation, the variable entered before it in the regression model was always nonsignificant. Of further interest is the fact that the same result was observed when a simultaneous multiple regression procedure was used; that is to say, imageability was the only significant variable among those in the third set. As can be seen from Table 5, the multiple regression analysis that included from Set 3 only imageability yielded the following reliable predictors: name agreement ($\beta = -.27$), image agreement ($\beta = -.23$), and imageability ($\beta = -.21$), objective word frequency ($\beta = -.15$), and AoA ($\beta = .16$). It is worth stressing that although the latter two variables were reliable, their corresponding beta weights were greatly reduced, as compared with the analysis including only the variables from sets 1 and 2.

In order to compare the present speeded naming data with those obtained with the same set of colorized pictures in French, we conducted multiple regression analyses with the same set of IVs used when studying Russian alone. The norms for image agreement, conceptual familiarity, and naming times were taken from the Rossion and Pourtois (2004) study. AoA and image variability scores were taken from the Alario and Ferrand (1999) study, while the objective word frequency and number of phonemes measures came from the New, Pallier, Brysbaert, and Ferrand (2004) database. Imageability and subjective frequency norms were available from Bonin, Méot, et al. (2003). Finally, the visual complexity scores were the same as those used in the multiple regressions for Russian. However, it was not possible to use the name agreement scores provided by Rossion and Pourtois as predictors in the regression analyses, because of several major problems that we identified and that had previously been mentioned in Tsaparina et al.'s (2011) study.[4] However, since name agreement is an important IV that must be taken into account when the determinants of object naming are investigated, we decided to collect new name agreement scores in French for the set of colorized SV pictures in order to overcome this difficulty. These were collected from 26 adults (mean age: 30.6) from the University of Bourgogne, using the procedure described in Tsaparina et al.'s study. The new name agreement norms[5] are available in Appendix C of the Supplemental Materials.

The multiple regression analyses conducted with the final set of IVs used when studying Russian alone revealed important differences between the two languages[6] (Table 7).

First of all, the initial phoneme characteristics were found to play an important role in Russian naming times, whereas this was not the case in French. Second, the opposite pattern was observed for the other sets. This was particularly true for set 2, which, in French, largely compensated for the low explanatory power of the initial phonemes' features. In particular within this set, AoA was highly significant in French but just failed to reach significance in Russian (p = .06). Moreover, although name agreement made a similar contribution in both languages, this was not the case for the image agreement variable, which, although it had the greatest effect in Russian, was not reliable in French. This finding in Russian contrasts with the observation in Chinese (Weekes et al., 2007) that image agreement has a smaller effect in picture naming when the colorized pictures are used. Finally, as far as the third set of IVs is concerned, the naming times were more closely linked to imageability in French than in Russian. Moreover, concerning the other variables belonging to this set, image variability in French was also reliable in a forward regression approach used only for this set.

Multiple regression analyses on object recognition times

The same type of multiple regression analysis as that used for object-naming times (but without the set of binary-coded features of initial phonemes) was employed to analyze the predictors of object recognition times. As can be seen from Table 5, with the notable exception of objective word frequency, the same significant predictors were found—namely, name agreement, image agreement, and AoA. None of the variables from the third set were found to be reliable when entered into the regression equation.

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[4] The presentation of the name agreement scores in the Rossion and Pourtois (2004) study suffered from problems in the organization (i.e., sequencing) of the items.

[5] We examined the correlations of the new French name agreement scores with the name agreement scores obtained in other studies that used the same object concepts (Alario & Ferrand, 1999; Dimitropoulou et al., 2009; Sanfeliù & Fernandez, 1996; Snodgrass & Vanderwart, 1980; Tsaparina et al., 2011) and found significant positive correlations. In contrast, the Rossion and Pourtois (2004) name agreement scores were uncorrelated with the other name agreement scores. This makes it absolutely clear that these norms could not reasonably have been used for comparison purposes.

[6] The results from the multiple regression comparing French and Russian are somewhat different from those reported in Table 5 because, in these analyses, only the items with no missing values on either IVs or dependent variables were included.

Table 7 Multiple regression analyses of picture-naming latencies in Russian and French

	Russian	French (without Ivar)	French (with Ivar)
R^2 set 1 (= initial phonemes features)	.133	.038	.038
R^2 set 1 + set 2 (Set 2 = NA, IA, AoA, VC, ObjFreq, Phon)	.431	.488	.488
R^2 with set 1 + set 2 + set 3 (forward entering) (Set 3 = Imag, Fam, SubjFreq, Ivar)	.457	.522	.552
NA	−.229***	−.244***	−.229***
IA	−.289***	−.086	−.195**
AoA	.134	.256**	.175*
ObjFreq	−.135*	−.084	.020
VC	−.005	.021	.016
Phon	.001	−.08	−.055
Imag	−.192***	−.290***	−.266***
Ivar			−.282***

Note. The names of the variables corresponding to the codes are provided in Table 3. For Russian, the scores of NA, IA, Fam, AoA, Imag, and VC were taken from Tsaparina, Bonin, and Méot (2011), and ObjFreq scores were taken from Lyashevskaya and Sharov (2008). For French, ObjFreq scores were taken from New, Pallier, Brysbaert, and Ferrand (2004); AoA and Ivar scores were taken from Alario and Ferrand (1999); IA, Fam, and naming times were taken from the Rossion and Pourtois (2004) study; Imag and SubjFreq were taken from Bonin, Méot, et al. (2003). VC scores were the same in both languages; NA scores for French were those collected anew.

*$p \leq .05$

**$p \leq .01$

***$p \leq .001$

General discussion

To summarize the main findings of the multiple regression analyses for both object-naming and object comprehension times, we found that three variables made a reliable contribution—namely, name agreement, image agreement, and AoA. We now discuss the findings for object naming and object comprehension in turn.

As far as object naming is concerned, the findings are consistent with previous studies that have shown that the most important predictors of object-naming times include name agreement and AoA (Alario et al., 2004; Bonin et al., 2002). Image agreement has not been systematically addressed in picture-naming studies, but those in which this variable has been taken into account have found it to exert a reliable influence (e.g., Barry et al., 1997; Bonin et al., 2002; Bonin, Peereman, et al., 2003; Nishimoto, Ueda, Miyawaki, Une, & Takahashi, 2012). Our finding that word frequency was a reliable predictor of picture-naming speed is completely consistent with the view that object naming requires access to word form representations that are stored on the basis of their frequency of encounter (e.g., Jescheniak & Levelt, 1994; Mädebach, Jescheniak, Oppermann, & Schriefers, 2011).

The image variability, BOI, and imageability variables are assumed to be genuine indexes of semantic code activation, because words associated with high imageability and/or image variability, and/or BOI ratings are thought to have richer sensory and/or motor representations than those with lower ratings on these dimensions. Since the semantic system is obligatorily involved in object naming (Bonin et al., 2012), we predicted reliable contributions of these variables to naming times. However, the multiple regression analyses revealed that neither BOI nor image variability made a reliable contribution. Only imageability—certainly the most prototypical semantic variable—was found to play a role in object naming. As far as the latter variable is concerned, it should be remembered that it has not been found to be a systematic, reliable predictor of object-naming speed (e.g., Barry et al., 1997, did not find an effect of this variable, whereas Bonin et al., 2004, did). It should be stressed that although image variabilty has not often been investigated in picture-naming studies, it has sometimes been found to be a reliable predictor of naming speed (e.g., in Alario et al., 2004[7]; in Bonin et al., 2002; but not in Bonin, Peereman, et al., 2003). However, in these picture-naming studies, imageability was not taken into account in addition to image variability. In the present study, we were able to show that imageability was a stronger predictor of naming speed than image variability. What exactly image variability measures remains an issue that deserves further study. Bonin, Méot, Ferrand, and Roux (2011) found that the correlation between this variable and imageability was reliable but not

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[7] Alario et al. (2004) wrote that they included "imageability" in their regression analyses of naming times in French. However, it is clear that the intended term was "image variability," as can be deduced from their description of the rating task (p. 143).

high (.43). Finally, the same question can be raised concerning imageability, which, as was stated above, is widely acknowledged as a semantic variable in the psycholinguistic literature. However, contrary to what might very well have been expected if this variable were a genuinely significant index of semantic richness, Bonin et al. (2011) found that its correlation with a number of semantic features was reliable but not large (.40). Indeed, it remains to be ascertained what precise aspects of semantic knowledge are captured by imageability (and image variability) norms.

The fact that BOI did not reliably predict naming times is surprising given that this variable has been found to play a role in tasks such as lexical decision, phonological lexical decision, insult detection (e.g., Siakaluk et al., 2008; Wellsby et al., Wellsby et al. 2010), and, importantly, object naming (e.g., Bennett et al., 2011). Bennett et al. used hierarchical multiple regression analyses for a set of items taken from the International Picture-Naming Project database (Szekely et al., 2004). In the first step, 13 dichotomous variables were entered to control for the effects of the initial phoneme. In the second step, objective visual complexity, HAL log-frequency, number of syllables, number of morphemes, Levenshtein phonological distance, and AoA were entered. Finally, imageability and BOI were entered in the third step. The important finding was that both imageability ($\beta = -.39$) and BOI ($\beta = -.13$) were reliable predictors of naming latencies. However, in their analyses, Bennett et al. did not include the important variables of name agreement and image agreement. It is therefore still unclear whether BOI and/or imageability would remain reliable if these variables were taken into account in the multiple regression analyses.

Subjective frequency was not reliable in any of the multiple regression analyses. It should be remembered that this variable has not been investigated very often in timed picture-naming studies. The only study that we are aware of that has taken subjective frequency into account is that of Liu et al. (2011). In a multiple regression analysis of object-naming latencies in Mandarin Chinese (important variables such as name agreement, conceptual familiarity, image agreement, rated AoA, etc. were introduced), the authors did not find any reliable contribution of this variable, even though objective word frequency was not introduced as a predictor in the different regression analyses. Following the work of Brysbaert and Cortese (2011), our goal was to identify the importance of subjective frequency, as compared with that of objective word frequency. The finding that subjective frequency was not reliable in object-naming latencies suggests that the subjective frequency norms do not add specific information or correct (potentially) poor objective word measurements in Russian.

In the introduction, we claimed that normative studies of timed picture naming are important because they help us gain a better understanding of the dynamics of spoken (but also written; see Bonin et al., 2002) word production. The findings from our study reinforce the view that object naming is a highly dynamic process that requires the recruitment of several types of knowledge. First of all, structural information is mobilized, as the finding of a reliable contribution of image agreement suggests. In addition, the reliable effects of imageability and name agreement indicate semantic code activation. It should be noted that, while the locus of the name agreement variable has been a subject of discussion, it has most often been assumed to index the semantic level (Bonin et al., 2012; Griffin & Bock, 1998). Most speech production models (e.g., Caramazza, 1997; Levelt et al., 1999) assume that, after the activation of the knowledge pertaining to the object recognition stage, there is a stage involving the activation and selection of lexical entries and phonological encoding. The contribution of the AoA and word frequency variables to picture-naming latencies is generally taken to argue for such a stage (but the locus of AoA effects has also been widely debated; see below). Finally, there is a stage corresponding to articulatory planning and execution. In our study, this was suggested by the reliable contribution of initial phoneme characteristics.

As far as the contribution of initial phoneme characteristics is concerned, it is worth mentioning that these accounted for more variance in picture-naming times in Russian than in French (.133 vs. .038). This finding was not anticipated. To gain understanding of this phenomenon, we examined the specific phoneme characteristics that reliably contributed to naming times. It appeared that among the initial phoneme features, only the voiced feature yielded a significant effect ($\beta = -.267$), $t(204) = -3.63$, $p < .001$, with the result that shorter naming times were associated with items comprising a voiced first phoneme. Although we have no explanation for this specific finding, it must be stressed that it does not undermine the other findings concerning the other predictors, since initial phoneme features are not reliably correlated with other visual/lexical/semantic variables (the R^2s between the initial phoneme features and the other variables varied between .02 and .078). It should be noted that, unlike the other variables (e.g., name agreement, AoA), the initial phoneme characteristics were not systematically introduced as predictors in other multiple regression studies of picture naming, which, as a result, limits the comparability of this specific finding.

Turning to object comprehension, we found that name agreement, image agreement, and AoA were reliable predictors of name–object verification times. Thus, our findings here are slightly different from those reported by Stadthagen-Gonzalez et al. (2009) and Bonin et al. (2006). In Stadthagen-Gonzalez et al., the (nonlexical) image agreement and conceptual familiarity variables were found to be reliable predictors of object recognition times, whereas the variables of name agreement, word frequency, and number of syllables were not. In the French study of Bonin et al. (2006), the imageability, name agreement, and image agreement variables had significant effects on the verification times for matched responses, while AoA and word frequency did not. While the locus of name agreement can be ascribed to the object comprehension level in the case of objects that are visually ambiguous (Vitkovitch & Tyrrell, 1995), as was stated above, this variable has most often been assumed to act at the semantic level (for further evidence, see Bonin et al., 2012; Griffin & Bock, 1998). Indeed, the key finding of our study is that objective word frequency was a reliable determinant of object-naming but not of object comprehension times. This is especially important since objective word frequency has been acknowledged to be a genuine index of the retrieval of word forms or word form encoding (e.g., Bonin et al., 2012; Mädebach et al., 2011). However, AoA was also a reliable predictor of object comprehension times, and skeptical readers might consider this finding to be very much at odds with the idea that the name–object verification task is a reliable way of indexing the prelexical (but not the lexical) levels involved in object naming, given that AoA has often been considered to be located at the level of word form representations in object naming (for reviews, see Johnston & Barry, 2006; Juhasz, 2005). It is not our intention here to reopen a debate concerning either the status of AoA measures or whether or not they have a genuine influence on lexical processing. We only wish to point out that among the variables that we took into account in the analyses, rated AoA is certainly one of the least understood. First of all, rated AoA measures have a truly composite nature (see Bonin et al., 2004; Zevin & Seidenberg, 2002), with the result that we still do not understand the extent to which rated AoA scores index the real age/order of acquisition of words. Thus, a number important methodological issues have been raised with regard to this variable (Bonin et al., 2004; Bonin, Méot, Mermillod, Ferrand, & Barry, 2009; Mermillod, Bonin, Méot, Ferrand, & Paindavoine, 2012; Zevin & Seidenberg, 2002). Second, the locus of rated AoA is still debated, since its influence has been ascribed to several potential loci: object comprehension, the semantic level, the word form level, and the link between lemmas and lexemes (see Johnston & Barry, 2006, for a comprehensive review). For these reasons, certain researchers have suggested making use of less controversial measures (i.e., frequency trajectory) and/or approaches (simulated learning, neural networks) to investigate age-limited learning effects in lexical processing (e.g., Ellis & Lambon Ralph, 2000; Izura et al., 2011; Mermillod et al., 2012). Frequency trajectory refers to variations in the acquisition of words over individuals' lifetimes and has been found to influence object naming but not word reading or spelling to dictation (Bonin et al., 2004; Zevin & Seidenberg, 2002, 2004). Unfortunately, in the present analyses, it was not possible to investigate the influence of frequency trajectory, since child frequency measures are not available in Russian. In our opinion, the important finding is that objective word frequency did not have a reliable effect on object comprehension times. This finding therefore strongly suggests that researchers can still confidently use the name–object verification task as a valid control task when it comes to indexing the prelexical levels involved in object naming.

To conclude, the present study provides important findings in object naming and object comprehension in Russian that help to better delineate the processes and representations that are involved in the two activities. It also provides additional norms for subjective frequency, BOI, and image variability for a set of 260 words, which will be very useful to researchers examining issues relating to memory and language.

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