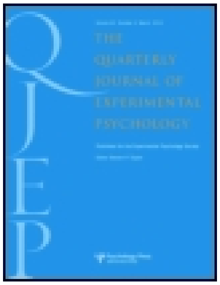

The Quarterly Journal of Experimental Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/pqje20

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Published online: 25 Sep 2013.

THE QUARTERLY JOURNAL OF EXPERIMENTAL PSYCHOLOGY, 2013
http://dx.doi.org/10.1080/17470218.2013.828317

Routledge
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The "BIG BIRD" of the "YELLOW YOUNG" man: Do nontarget properties cascade?

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This study investigated whether in speech production object properties flow in a cascaded manner or whether cascaded processing is restricted to the object's identity. In Experiments 1 and 2, participants saw pictured objects and had to state either their size (GRAND or PETIT—meaning *big* and *small*) or their name. The size of the objects varied as a function of the way they were presented on the computer screen (Experiment 1) or their real size in the world (Experiment 2). In Experiment 3, faces of young and old men were coloured in yellow or in green. The task was to name either the colour (JAUNE or VERT, meaning *yellow* and *green*, respectively) or the age (JEUNE or VIEUX, meaning *young* and *old*, respectively) of the face. In Experiments 1 and 2, no reliable effects of phonological relatedness ("GORILLE–*grand*"—a big gorilla) were found on the object-naming latencies. However, size-naming latencies were shorter when the adjective shared the initial phoneme of the picture name (i.e., "GRAND–*gorille*") than when it did not (i.e., "GRAND–dinosaure"—saying "*big*" in response to a big dinosaur). In Experiment 3, phonological overlap did not affect colour naming latencies, or age naming latencies. Overall, these findings strongly suggest that cascaded processing is restricted to the object's identity in conceptually driven naming tasks.

Keywords: Picture naming; Cascaded processing; Object property; Size naming; Colour naming.

It is generally admitted that from the intention to communicate a message to its verbal expression there are three main processing levels: semantic, lexical, and articulatory (Caramazza, 1997; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt, Roelofs, & Meyer, 1999). Although researchers disagree on issues such as the nature and precise number of processing levels involved in speech production (Caramazza, 1997; Levelt et al., 1999), the main debate concerns the way in which information flows between these processing levels (see Goldrick, 2006; Rapp & Goldrick, 2000, for theoretical discussions). There are essentially two views on this issue. The "discrete-serial" view assumes that, after conceptual processing, there is a lexical processing stage during which a single lexical unit is selected among the cohort of activated lexical units (Levelt et al., 1999). A crucial point in this approach is that *only* the selected lexical unit is phonologically encoded. As a result, only the intended concept—namely, the one the speaker wishes to express—will have its

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The authors wish to thank Niels Janssen, Diane Pecher, Rolf Zwaan, and two anonymous reviewers for very helpful comments on a previous version of our paper. This work was supported by a grant from the Conseil Régional de Bourgogne to the first author and by a grant from the Institut universitaire de France to the second and third author.

name ultimately phonologically encoded. This conception of speech production is at odds with a growing body of chronometric experiments suggesting that information flows in a cascaded manner (e.g., Morsella & Miozzo, 2002; Peterson & Savoy, 1998). According to this widely supported "cascading" perspective, activation spreads through the speaker's lexical system in such a way that not only the intended concept, but also other activated concepts, send part of their activation to their corresponding phonological units (Caramazza, 1997; Cutting & Ferreira, 1999; Damian & Martin, 1999; Humphreys, Riddoch, & Quinlan, 1988; but see Bloem & LaHeij, 2003, for a different version of the cascading view of speech production). In other words, the essential question is whether or not a concept is encoded phonologically even when it is not the one the speaker wants to express.

Recently, the cascading view of speech production has received strong empirical support from the phonological facilitation effect (PFE) found in the picture–picture paradigm. This effect was originally reported by Morsella and Miozzo (2002). English native speakers saw composite pictures consisting of a target line-drawing (coloured in green) and a nontarget (context) drawing (coloured in red). The two pictures were superimposed, and their names could be either phonologically related (e.g., "BED–bell"), or unrelated. The participants had to name in English the target in green while ignoring the nontarget in red. Naming latencies were shorter when the targets were presented with phonologically related context pictures than with unrelated context pictures. This effect vanished in a cross-linguistic "control" experiment, where the same pictures were named by monolingual Italian native speakers, for whom the names of the target and nontarget pictures did not share any phonemes. This ruled out an account of the PFE in terms of difficulties arising at the perceptual–conceptual level, whereby the PFE would have been observed regardless of the production language.

Overall, these findings suggest that both target and nontarget concepts send activation to their corresponding phonological units. When the picture names are phonologically related, the shared phonemes receive more activation than in situations where the picture names are not phonologically related. The naming speed is therefore faster when the picture names share phonemes than when they do not. The PFE has been replicated in English (Meyer & Damian, 2007) and has also been observed in other languages (Spanish: Navarrete & Costa, 2005; Dutch: Roelofs, 2008; French: Roux & Bonin, 2012, for the written modality; but see also Jescheniak et al., 2009). Overall, the findings in object naming with the picture–picture interference paradigm favour a cascading view of spoken naming in which activation flows continuously from the conceptual to the phonological level.

One important issue relates to precisely *how* information flows in a cascading architecture of language production. In particular, it is still uncertain whether all activated nontarget concepts are automatically encoded phonologically (i.e., the "*full-cascading*" account) or whether there is some restriction on the phonological activation of nontarget concepts (i.e., the "*limited-cascading*" account). We therefore distinguish between the "full-cascading" and the "limited-cascading" view. According to Kuipers and La Heij (2009): "The full-cascading position holds that this flow is not under voluntary control. That is, any active concept (activated directly by sensory information or indirectly via spreading activation) activates the corresponding lexical representations, irrespective of whether this activation serves the speaker's communicative goal" (p. 131). By "limited-cascading", we simply mean that, within the language production architecture, the flow of information is restricted in some way, so that all the activated concepts do not systematically send activation to the phonological level (see the Bonin, Roux, Barry, & Canell, 2012, study for further evidence and discussion). The full-cascading view has been challenged by findings in colour naming and coloured-object naming. In these tasks, which make use of coloured line drawings, participants have either to name the colour of the picture (i.e., colour naming) while ignoring the name of the object, or to name the object while ignoring its colour (i.e., coloured-object naming). Navarrete and Costa (2005; see also Dumay & Damian, 2011) reported a PFE in colour naming in Spanish. Speakers named the colour of objects faster when the colour name was phonologically related to the object name (e.g., "VERDE–vela", meaning "GREEN–candle") than when it was unrelated. This finding suggests that, although colour and object differ in dimension and grammatical class, both concepts transmit some activation at the phonological level during colour naming. In contrast, Kuipers and La Heij (2009; see also Mädebach, Alekseeva, & Jescheniak, 2011) failed to observe a PFE when naming coloured pictures in Dutch. The phonological relationship between the name of an object and the name of its colour did not affect object-naming latencies in Dutch speakers. This suggests that the nontarget colour property is not encoded phonologically when the task requires participants to name the object's identity. In sum, there is an *asymmetry* between object and colour naming in the emergence of a PFE. This is clearly problematic for the full-cascading view, according to which any activated concept should be automatically encoded phonologically, irrespective of the dimension it refers to (identity or property). In contrast, these findings suggest that the flow of information is restricted in some way, with the result that not all the activated concepts systematically send activation to the phonological level. More precisely, nontarget concepts do not seem to be processed in a cascaded fashion if they refer to object properties (i.e., at least for colour properties).

The limited-cascading view: Does a nontarget property cascade?

In real-life situations, speakers often use an object's property to refer unambiguously to a given object among other objects in the visual scene. Thus, it is not unreasonable to hypothesize that the properties of objects (colour, shape, or size) become phonologically encoded even in communication situations where they are not relevant. To our knowledge, Janssen, Alario, and Caramazza's (2008) study is the only one that supports the idea that the activation of a nontarget (colour) property propagates to the phonological level in isolated word production. A PFE was found in English for coloured-object naming (e.g., producing "box" for a box coloured blue), but not for colour naming (e.g., producing "blue"). Thus, the property (i.e., colour name) appeared to be phonologically activated during object naming in English whereas the identity (i.e., the object's name) did not seem to be phonologically activated during colour naming. Since the reverse pattern had been found in French (Janssen et al., 2008), the authors assumed that the asymmetry between object and colour naming in the emergence of a PFE was language dependent. According to the authors, syntactic specifications—word order rules—restrict the flow of activation in spoken word production. More precisely, the amount of activation that a noun or adjective receives depends on their canonical position, which varies between languages. This word-order constraint hypothesis (Janssen et al., 2008) holds that nontarget concepts cascade to the phonological level, irrespective of the object's identity or property. However, their activation is modulated by the typical noun–adjective position in a given language. In English, adjectives are typically *pronominal* (i.e., occur before the noun, "*a green car*"). They receive more activation than the nouns that follow them. This means that if there is a phonological overlap between the object's identity and colour, the phonological activation of the adjective boosts the activation of the noun due to the shared phonemes. This would explain why object naming is facilitated in English. Conversely, the shared phonological units confer no benefit when participants are asked to name the colour of an object because the noun typically occurs after the adjective and receives less activation. Thus, the phonology of the noun cannot boost the activation of the adjective in English colour naming. In French, however, colour adjectives are typically *postnominal* (i.e., occur after the noun; e.g., "*une voiture verte*", a green car). They receive less activation than the nouns that precede them. Thus, colour naming in French is influenced by the phonological activation of the object name, whereas object naming is not modulated by the (smaller) phonological activation of the colour adjective. In sum, Janssen et al. (2008)

proposed that the phonological activation of a nontarget property is modulated by the linear relationship between words (i.e., pronominal adjectives versus postnominal adjectives). However, recent studies have cast doubt on Janssen et al.'s findings. First of all, Kuipers and La Heij (2009; see also Mädebach et al., 2011) reported a PFE in colour naming in Dutch. Colour naming was facilitated by the phonological overlap between colour and object names, whereas object naming was not. This result is at odds with the word-order hypothesis, since colour adjectives in Dutch are also pronominal and should have elicited the same pattern of results as that in English. Second, new data from Dumay and Damian (2011) in English failed to replicate the pattern of findings reported by Janssen et al. They found instead, as in French and Dutch, a reliable PFE in colour naming, but not in object naming. There is therefore no clear evidence to date that nontarget properties spread activation to the phonological level. This issue clearly requires further investigation.

Does a nontarget property cascade during object naming? According to Dumay and Damian (2011), the phonological activation of nontarget concepts is limited in the sense that the identity of an object always has the priority over its attributes (Dumay & Damian, 2011). In this view, no phonological activation of nontarget properties is expected in object naming. Maybe the activation of nontarget properties is too weak to reliably affect naming latencies compared to the stronger activation spreading from the object's identity. It could also be that the processing of object properties is restricted to the preverbal level. Importantly, such a restriction is not incompatible with a cascaded view. Indeed, it is possible to hypothesize that the activation of the object's identity (i.e., the object concept) spreads freely through the cognitive system, whereas the object's property does not. Therefore, throughout this paper, we use the term "limited cascading" to indicate the idea that certain concepts (e.g., identity concepts) transmit their activation to the lexical level whereas others (property concepts perhaps) do not.

In contrast, according to the word-order hypothesis (Janssen et al., 2008), nontarget concepts should activate their phonology irrespective of the object's identity or property, but this activation is modulated by the linear relationship between words. In this view, reliable phonological activation of a nontarget property can be observed only if the corresponding adjective typically occurs before the noun. Indeed, adjectives are thought to receive more activation than nouns when they typically occur before than when they occur after it. It is noteworthy that previous studies that have examined the activation flow of the properties of nontarget objects have focused on the colour property. No clear evidence of cascaded activation has been found in connection with this property, leading to the conclusion that nontarget properties do not cascade. Does this conclusion also apply to other types of perceptual properties such as the object's size or age? These two dimensions are particularly suitable for examining this questions because in French, size and age adjectives related to objects, or to people, are pronominal.

Indeed, sentences of the type "**adjective** + noun" (e.g., "*un **petit** vélo*", a small bike) are generally used for other attributes corresponding to objects such as size (e.g., "big", "small"). According to Janssen et al.'s (2008) account, the amount of activation an adjective receives (a) depends on the typical adjective–noun order and (b) is greater for pronominal than for postnominal adjectives. Importantly, size- and age-naming tasks in French strictly parallel the colour-naming task that Janssen et al. (2008) conducted in English, since all these adjectives are pronominal in their respective languages. Thus, in French, size adjectives should maximize the probability of observing a phonological activation of the nontarget size property during object naming. This issue was addressed in Experiments 1 and 2. Note that all the previous studies that failed to observe the phonological activation of nontarget properties were object-naming studies. It is likely that the phonological activation of nontarget properties was undetected in naming latencies because it was masked by the stronger phonological activation spreading from the object's identity. We tested this hypothesis in Experiment 3. Target objects that have no intended names (i.e., unknown faces) were used to examine how the activation of nontarget properties flows in a naming situation where the object's identity cannot mask the phonological activation of its properties. In effect, for a given participant an unknown face corresponds to someone with no identity and cannot be given a proper name, unlike a famous face whose identity is known and for which a proper name can be retrieved (e.g., Mick Jagger).

EXPERIMENT 1: SIZE AND OBJECT NAMING

In this experiment, participants were presented with object drawings that varied in size (i.e., "grand" or "petit"—big or small) and had to state either the name of the depicted object or its size. Object names were either phonologically related to the size adjective GRAND (e.g., GORILLE, *a gorilla*) or unrelated. The full-cascading view predicts a PFE in both tasks—namely, shorter size- and object-naming latencies for related than for unrelated pictures—whereas according to the limited-cascading view a PFE should emerge only on size-naming latencies. Importantly, we did not manipulate the phonological relationship between the picture names and the size adjective PETIT (*small*) because we expected longer latencies for drawings displayed in a small format on the screen than for those displayed in a larger one. Indeed, in Konkle and Olivia's (2012) study, size judgements were slower for small than for large objects. This delay could have potentially cancelled out any benefit in naming performance because of phoneme overlap in the congruent condition compared to the control condition.

Method

Participants

Forty-two psychology students from the University of Bourgogne took part in this experiment in exchange for course credit. All were French native speakers and had a normal or corrected-to-normal vision.

Stimuli

Thirty black-and-white drawings were selected form the Cycowicz, Friedman, Rothstein, and Snodgrass (1997) picture database. The name agreement for each picture, taken from Alario and Ferrand (1999), was at least 80%. There were 15 pictures whose names were phonologically related to the size adjective GRAND (big; e.g., GUITARE, *a guitar*), and these are referred to as "G-pictures" in the following. The remaining 15 pictures had names that were not phonologically related to any size adjective and served as control pictures (e.g., BAIGNOIRE, *a bathtub*). The "G-pictures" and "other (non-G) pictures" were matched on a number of dimensions including image agreement and visual complexity (see Table 1).

Table 1. *Statistical characteristics of the experimental pictures used in Experiment 1*

Characteristic	*"G-pictures"*	*Control pictures*	p *values*
Name agreement (%)[a]	79	79.29	*ns*
Visual complexity[a]	3.14	3.02	*ns*
Conceptual familiarity[a]	3.05	3.08	*ns*
Image variability[a]	2.91	2.67	*ns*
Lexical frequency[b] (log)	1.03	0.90	*ns*
Number of phonemes[b]	4.67	4.53	*ns*
Number of syllables[b]	1.60	1.87	*ns*
Diphone frequency[b] (log)	3.34	3.25	*ns*

Note: Visual complexity (rated on a 5-point scale) refers to the number of details or to the intricacy of the lines in each drawing; conceptual familiarity (rated on a 5-point scale) refers to how usual or unusual the depicted objects are for the speaker (Bonin, Peereman, Malardier, Méot, & Chalard, 2003).
[a]Taken from Alario and Ferrand (1999). [b]Taken from LEXIQUE (New et al., 2001).

To ensure that the French size adjective GRAND always occurred before the noun for each selected picture, we examined our material in detail using the Google Ngrams search tool to find occurrences in recently published books (2000–2009; see Brysbaert, Keuleers, & New, 2011). We found that size adjectives are quite systematically located before the noun (pronominal adjectives such as "un *grand* gorille", a *big gorilla*). Thus, verbal expressions in which size adjectives occur after nouns (e.g., "un gorille *grand*") are almost nonexistent. A list of the stimuli used in this experiment is provided in Appendix A. All the drawings were resized with Photoshop CS 8.0.1 to create three picture sets, each consisting of 30 pictures of varying size. Fifteen "G-pictures" and 15 control pictures were fitted inside a 14-cm square and were considered as "big pictures". The 15 "G-pictures" were therefore phonologically related to the size of the drawings (e.g., "GRAND–gorille", *a big gorilla*) and constituted the congruent condition. Object names and the adjective "GRAND" shared at least the initial phoneme, with a mean overlap of 1.47 phonemes on the onset. (Even when all phonemes are considered, and independently of their position in the words, the overall phonological overlap between name and size adjective was 41% in the related condition and only 13% in the control condition.) In contrast, there was no such a phonological relationship between object name and size adjective "GRAND" for the remaining 15 pictures (e.g., "GRAND–chateau", *a big castle*), which constituted the control condition. In the "small pictures" set, the drawings fitted into a 3.5-cm square. Finally, a "medium pictures" set was created, in which the drawings fitted into a 7-cm square. This third set was introduced to prevent participants from anticipating the different possible responses. It is essential to stress that there was no phonological overlap between the picture names and their size in the medium and small picture sets. These sets were created for use in the size-naming task and also served as filler pictures to reduce the proportion of related trials. Overall, there were 90 experimental stimuli.

Apparatus

The pictures were displayed on a 17-inch iMac computer screen. The presentation and randomization of the stimuli were controlled by PsyScope v.1.2.5 (Cohen, MacWhinney, Flatt, & Provost, 1993) running on OSX Macintosh computer. Naming latencies were recorded via a microphone (Sennheiser ME 64).

Procedure

The participants were tested individually in a quiet room. Before the naming experiment, each picture was presented in the three sizes during a familiarization phase. The participants were asked to pay attention to the intended names and different sizes. At the beginning of the experimental phase, half of the participants were instructed to name the size of each picture (i.e., size naming), whereas the other half were told to name the object (i.e., object naming). The experimental phase consisted of 90 trials. Both tasks had the same trial structure based on Janssen et al.'s (2008) experiments: Each trial began with a fixation cross presented for 700 ms, followed by a 200-ms blank screen. The target picture was then displayed in one of three sizes. Depending on the group, the participants had to name aloud either the name of the object or its size. In the size-naming task, participants had to produce the adjective GRAND (big), MOYEN (medium), or PETIT (small) depending on the display size of the pictures. In object naming, participants had to produce the name of the depicted object (starting either with /g/, or another phoneme) irrespective of the size of drawings. In each task, articulatory (naming) latencies were recorded with a voice key. Each picture remained on the screen until the participant gave a response, or for a maximum of 2500 ms. The intertrial interval was set to 2500 ms. The 90 trials were divided into three blocks of 30 trials each. The presentation order of the three blocks was counterbalanced. Each block contained 10 "big" pictures and 20 "filler" pictures (10 medium and 10 small pictures). Likewise, trials with a phonological overlap between size and object name occurred five times per block, for the "big" pictures only. Overall, the proportion of critical trials (big "G-pictures"; e.g., GORILLE, *a gorilla*, related to the adjective "grand") was about 17%. For these latter trials, the mean phonological overlap between the object name and the adjective GRAND was 1.47 phonemes. When conducting the object-naming task, we made use of a particular methodological precaution that should be pointed out here. Because of the experimental design, target pictures in the "related" condition all shared the same initial phoneme (i.e., /g/ as in GORILLE) whereas the control pictures did not (e.g., CHATEAU). Due to this systematic difference in initial phonemes, the acoustic intensity with which the first phoneme of each word triggered the voice key varied across the two experimental conditions. Consequently, it would be not surprising to find that these acoustic differences affected the recording of object-naming latencies. We controlled for these differences by asking the participants to perform a delayed object-naming task that took place immediately after the object-naming task. The idea was that if acoustic differences influence naming latencies in immediate object naming, this influence should also be found in delayed object naming. In sum, an advantage for related over unrelated trials in immediate object naming, but not in delayed object naming, would reveal the phonological activation of nontarget adjectives. In contrast, the same effect in both immediate and delayed object naming would suggest an influence due to differences in the initial acoustic onsets of the names. The delayed naming task consisted of the same number of trials as the immediate object-naming task. The structure of the trials was the same as that in the immediate object-naming task except that a "beep" was presented via headphones at a comfortable sound level after the onset of the picture presentation. The participants were instructed to wait for this signal before naming the picture. The delay between picture onset and the beep varied randomly between 1200 ms and 1500 ms to prevent anticipatory responses. There was a 1500-ms interval between two consecutive trials. The delayed naming phase was preceded by 15 training trials. For both object and size naming, the experimental phase started with 15 warm-up trials using different pictures. The whole experiment lasted approximately 20 minutes in the size-naming condition and 35 minutes in the object-naming condition.

Results

Trials with technical errors, including hesitations and unexpected noise in the microphone, were excluded from the analyses. Latencies associated with the production of a name other than the intended one were also discarded. Two participants (one in the size-naming task and one in the immediate/delayed object-naming task) were excluded because they exhibited a high error rate (more than 20%). Finally, we applied the same exclusion criteria for both size naming and (immediate and delayed) object naming. In each condition, latencies exceeding 3 standard deviations above or below each participant and item mean were considered as extreme latencies and were rejected. The results were analysed using linear

Table 2. *Mean latencies, standard deviations, and naming error rates in congruent and control conditions, in size naming and object naming in Experiment 1*

	Congruent condition			*Control condition*		
Type of task	*Lat.*	SD	*Naming error rates (%)*	*Lat.*	SD	*Naming error rates (%)*
Size naming	527	66	0.05	552	64	0.6
Object naming						
Immediate	623	70	0.6	642	68	2
Delayed	284	76	0.01	305	74	0.01

Note: Lat. = latency in ms. Object naming: immediate versus delayed.

mixed effects models (Baayen, Davidson, & Bates, 2008; Bates, 2005), which simultaneously take participant and item variability into account. These analyses were performed using the R software (R Development Core Team, 2008) with the lme4 package (Bates & Maechler, 2009). Statistical analyses were performed on naming latencies and error rates using a logistic transformation function. Mean latencies, standard deviations, and naming error rates are presented in Table 2.

Size naming
Six percent of the data corresponded to technical errors, 4.6% to the production of an incorrect size name, and less than 0.5% to extreme latencies. There were no reliable effects of relatedness on technical errors, or on naming errors, both $z < 1$. Participants made fewer size-naming errors (0.05%) in response to pictures in the congruent condition (i.e., "G-pictures" with a big size) than for pictures in the control condition (0.67%). As Table 2 shows, the size was named significantly faster (527 ms) for pictures in the congruent condition (e.g., saying "grand", *big*, for the picture GORILLE, a *gorilla*) than for pictures in the control condition (552 ms; e.g., saying "grand" for the picture CHATEAU, *a castle*), $t(545) = 2.7, p < .01$.

Immediate object naming
Seven percent of the data corresponded to technical errors, 1.2% to the production of an erroneous picture name, and 2.4% to extreme latencies. No significant effects of relatedness were found on either technical errors or naming errors, all zs < 1. Of vital importance for the purposes of our study is the fact that immediate object-naming latencies did not differ reliably between the congruent pictures (e.g., naming "gorille" for a big picture of a gorilla) and the control pictures, $t(542) = 0.714$. However, a descriptive advantage for congruent pictures over control pictures was found (–19 ms).

Delayed object naming
Three percent of the data corresponded to technical errors and 1.6% to extreme latencies, and there were virtually no naming errors (less than 0.5%). There was no reliable effect of relatedness on technical errors, $z < .1$. Picture-naming latencies were significantly shorter in the delayed (295.2 ms) than in the immediate naming task (632.5 ms), $t(1122) = 50.01, p < .001$. Because of uncontrolled acoustic differences in word-initial phonemes, delayed naming latencies were significantly shorter in the congruent condition than in the control condition, $t(578) = 2.941, p < .005$.

Discussion

A phonological facilitation effect (PFE) was found on size-naming latencies. The picture size GRAND was named faster when it was related to the object name (e.g., GORILLE) than when it was unrelated (e.g., BAIGNOIRE), suggesting that the phonological encoding of the object name is involved when naming its size. An alternative explanation of the PFE in size naming could be that difficulties arising at the perceptual level influenced the size-naming task. Despite the fact that congruent and control pictures were matched for *rated* visual complexity, it could be argued that these ratings do not truly index the difficulties arising at the object comprehension level involved in picture naming. We therefore considered a different measure of visual complexity. The objective visual complexity measure (Székely & Bates, 2000) that we used was the number of pixels in each picture in JEPG format. Importantly, the PFE in size naming was still significant when the number of pixels was introduced as a covariate factor, $t(545) = 2.374, p < .01$. It is noteworthy that, from a logical point of view, the PFE cannot be attributed to articulatory differences between the two sets of pictures because the participants produced the same word (i.e., GRAND) in both conditions. Thus, the PFE found in size naming strongly suggests that object names are phonologically activated.

In contrast, no reliable PFE was observed in immediate object naming, despite a nonsignificant 19-ms trend. In delayed object naming, however, a significant advantage for the congruent over the control condition emerged. This difference cannot be explained in terms of phonological encoding, which is assumed to be achieved during the delay preceding the initialization of articulatory responses. We consider this result to reflect differences in the acoustic intensity of words. Indeed, picture labels in the congruent condition all had the same initial phoneme (/g/; e.g., GORILLE, GUITARE), whereas picture labels in the control (incongruent) condition had different initial phonemes (e.g., /b/ in BAIGNOIRE, /m/ in MOUSTIQUE, *mosquito*). The acoustic intensity with which the participants' responses triggered the voice key therefore varied between the experimental conditions. This clearly affected latency recording. This interpretation is confirmed by an additional analysis in which the advantage for congruent pictures on delayed naming latencies statistically vanished when the frequency of initial phonemes, taken from LEXIQUE (New et al., 2001), was entered as a covariate, $t(578) = 1.463$, $p > .1$. The fact that the acoustic properties of initial phonemes were not controlled for between the congruent and control condition also accounts for the nonsignificant 19-ms difference in the immediate object-naming task. However, to eliminate the hypothesis that this tendency was due to the phonological activation of the (nontarget) size, we computed "corrected" latencies by subtracting delayed naming latencies from immediate naming latencies. Again, corrected object-naming latencies were not significantly shorter for the related pictures (346.7 ms) than for the control pictures (344.5 ms), $t(524) < 1$. As a result, the (nonsignificant) advantage for the congruent over the control pictures in immediate object naming cannot be attributed to the phonological activation of the size adjective. This trend most probably reflects the differences between the two experimental conditions in terms of the articulatory characteristics of the initial phonemes of the picture names. Taken together, these results do not support the hypothesis of a phonological activation of nontarget properties.

To summarize, Experiment 1 replicates previous findings (e.g., Kuipers & La Heij, 2009; Navarrete & Costa, 2005) using a new paradigm, suggesting that object identity is phonologically activated even if the task only requires naming one of the object's properties. However, there is no evidence that object properties are phonologically activated during object naming, even though we used a property (i.e., the size) that had not previously been investigated. Another interesting outcome of Experiment 1 is that the results do not support the idea that the relative positions of the noun and the adjective constrain the phonological activation flow in isolated object naming (Janssen et al., 2008). Indeed, the word-order constraint hypothesis (Janssen et al., 2008) predicts a PFE when nontarget properties correspond to pronominal adjectives. As a result, a PFE should have been observed in object naming but not in size naming. Our findings are clearly at odds with these predictions. The outcome of the experiment is instead consistent with Dumay and Damian's (2011) view. They proposed that the object's identity prevails on its attributes during the cascading process and is phonologically activated during the naming of the object's property (the reverse does not apply).

Alternatively, the failure to detect a reliable PFE in object naming in Experiment 1 could be due to discrepancies between the size of the objects depicted on the screen and their real size in the world. Konkle and Olivia (2011) recently claimed that the real-world size of objects is a fundamental component of the corresponding visual representations that are automatically activated at the conceptual level during object recognition. They observed longer recognition latencies when the real-world size of objects was not congruent with the corresponding display size on the computer screen (i.e., small objects displayed as large pictures, big objects displayed as small pictures) than when the two sizes were congruent. We therefore took a closer look at the 15 pictures used in Experiment 1. We found that 12 of them were presented on the screen in a size that was incongruent with their real size in the world. For example, GRENOUILLE (*frog*), which refers to a rather small object, was displayed as a large image. This may have slowed down the visual recognition of pictures in the "related" condition, thereby increasing naming latencies. The PFE in immediate object naming might have been cancelled out by this size-incongruence effect. To clarify this issue, we decided to run another naming experiment in which all the pictures had the same size on the computer screen even though the real-world size of the objects they depicted varied.

EXPERIMENT 2: SIZE AND OBJECT NAMING OF BIG AND SMALL OBJECTS

Experiment 2 tested the same predictions as those in Experiment 1 but with three major improvements. First, we used objects that varied as a function of their real size in the world, but had the same actual size on the computer screen. Thus, because we now expected the same visual processing to occur for big and small pictures, we manipulated the phonological overlap between the objects' names and their size for both "big" and "small" objects, which was not the case in the previous experiment. Second, we increased the saliency of the size concept by using a size categorization task before the naming experiment in order to optimize the observation of a reliable PFE in object naming if it exists. Third, the related trials consisted of both "G-" and "P-pictures". Finally, as in Experiment 1, we included a delayed naming task to test for articulatory contributions in the naming latencies of the object-naming task.

Method

Participants

Fifty undergraduate students from the University of Bourgogne participated in this experiment in exchange for course credits. They all satisfied the same requirements as those used in the previous experiments.

Stimuli

Fifty-eight drawings were used in this experiment. All the drawings were resized to fit a 9-cm square, with the result that all the pictures had the same size on the computer screen. The "related" (i.e., congruent) condition consisted of 29 pictures whose object names were phonologically related to the adjective corresponding to their real-world size (e.g., GORILLE, *gorilla,* and PIED, *foot,* were related to the adjectives GRAND, *big*, and PETIT, *small*, respectively). Object names and size adjectives shared at least the initial phoneme, with a mean overlap of 1.2 phonemes. The control condition consisted of 29 other line-drawings with no phonological overlap between their names and the corresponding size. (Even when all phonemes are considered, and independently of their position in the words, the overall phonological overlap between the name and size adjective was 30% in the related condition and only 12% in the control condition.)

Fifty-two pictures were taken from the same database as that used in Experiment 1. However, there were only three pictures in the database that represented big objects and whose labels were also phonologically related to the corresponding adjective GRAND (i.e., GARAGE, GRANGE, and GORILLE). We therefore decided to create additional pictures that satisfied these requirements. Likewise, seven new pictures were found in order to extend the experimental set (see Appendix B). Since psycholinguistic norms were not available for these pictures and their names, we had to collect them. We decided to collect norms for the whole picture set (including the seven new pictures) on the following dimensions: picture–name agreement, conceptual familiarity, age of acquisition, and the estimated real-world size of the depicted object. These norms were collected from 40 undergraduate psychology students who did not take part in the naming experiment. We used the instructions provided by Alario and Ferrand (1999) to collect the norms. On a 5-point scale, objects whose names are phonologically related to the adjective GRAND (*big*) were estimated as bigger (4.15) than those with labels phonologically related to the adjective PETIT (*small;* 1.58), $t(56) = 288$, $p < .001$. Importantly, for the items that were also used in Alario and Ferrand's study, the conceptual familiarity and age of acquisition (AoA) norms collected here were strongly correlated, $r(43) = .882$, $p < .001$, and $r(43) = .961$, $p < .001$, respectively. As in Experiment 1, visual complexity was estimated by using the file size (in bytes) of each picture (Székely & Bates, 2000). Related and

Table 3. *Statistical characteristics of the experimental pictures used in Experiment 2*

Characteristic	*Related pictures*	*Control pictures*	p *values*
Picture–name agreement (%)[a]	4.2	4.2	*ns*
Image complexity[b]	179	189	*ns*
Conceptual familiarity[c]	3.4	3.3	*ns*
Age of acquisition (AoA)[a]	2.1	2	*ns*
Estimated size[a]	2.5	2.4	*ns*
Lexical frequency[c] (log)	1.2	1.9	*ns*
Number of phonemes[c]	4.8	4.6	*ns*
Number of syllables[c]	1.8	1.9	*ns*
Diphone frequency[c] (log)	2.3	2.2	*ns*

[a]Collected by us. [b]Estimated from the image file size in bytes (Székely & Bates, 2000). [c]Taken from LEXIQUE (New et al., 2001).

control pictures were matched across several dimensions, which are listed in Table 3. Finally, 18 filler pictures representing “big” objects were selected in order to obtain the same proportion of “big” and “small” pictures in the naming experiment. However, none of their names was phonologically related to the adjective corresponding to their size (i.e., GRAND), and they were not considered as belonging to the experimental set. To summarize, 76 pictures were used: 29 “related” pictures, 29 control pictures, and 18 filler pictures.

Apparatus

The pictures were displayed on a 17″ iMac computer screen. The presentation and randomization of the stimuli were controlled by PsyScope v.1.2.5 (Cohen et al., 1993) running on OSX Macintosh computer. Naming latencies were recorded via a microphone (Sennheiser ME 64).

Procedure

The participants were tested individually in a quiet room. Before the naming experiment, each picture was presented twice together with its name during a familiarization phase. The participants then performed a “size categorization task”. Forty grey circles were randomly displayed in the centre of the screen, and the participants had to categorize them as quickly (and accurately) as possible using two response-buttons of the keyboard. The circles were either “big” or “small” depending on their diameter on the screen (either 2 cm or 8 cm). This size familiarization task was introduced to render the size property more salient in order to maximize the chance of detecting an effect in object naming. At the beginning of the experimental phase, half of the participants were instructed to name the size of the pictures (i.e., size naming), whereas the remaining half were told to name the objects (i.e., object naming). They were informed that all the objects could be considered as either “big” or “small” depending on their real-world size. The experimental phase consisted of 76 trials, which had the same structure as that in Experiment 1. Trials were divided into two blocks of 38 trials each. The order of the blocks was counterbalanced. Each block contained the same proportion of related and control trials and the same proportion of “big” and “small” pictures. Overall, the proportion of critical related trials (e.g., GORILLE, *gorilla*, related to the adjective GRAND, or PIED, *foot,* related to the adjective PETIT, *small*) was about 38%. For both the object- and size-naming tasks, the experimental phase was preceded by 15 warm-up trials.

Participants who were involved in the (immediate) naming task had to perform a delayed object-naming task immediately afterwards. This was done to control for any acoustic differences between the names used in the related and unrelated conditions. The delayed naming task was the same as that used in Experiment 1 with 15 training trials. The whole experiment lasted approximately 25 min in the size-naming condition and 40 min in the object-naming condition.

Results

Trials with unexpected noises in the microphone or mispronunciations were considered as technical errors and were excluded from the analyses. Latencies associated with hesitations or with the production of a word other than the intended one (i.e., incorrect productions) were also excluded from the analyses. Finally, the same exclusion criteria as those used in Experiment 1 were applied to all the naming tasks. The remaining data were analysed as in Experiment 1. The statistical analyses were performed on size- and object-naming latencies as well as on error rates. Mean latencies, standard deviations, and naming error rates are presented in Table 4.

Size naming

Eight percent of the data corresponded to technical errors, 2.3% to the production of an incorrect size adjective, and 2.3% to extreme latencies. No reliable effects of relatedness were found either on technical errors or on naming errors, all zs < 1. As can be seen in Table 4, size naming was faster in the "related" than in the control condition, $t(1259) = 2.13$, $p < .05$. Thus, a PFE (–13 ms) was found on size-naming latencies.

Immediate object naming

Two participants produced more than 20% unexpected noise and/or naming errors and were eliminated from the analyses. Eight percent of the data corresponded to technical errors, 2.2% to the production of an erroneous picture name, and 1.1% to extreme latencies. No significant relatedness effects were found on technical errors, $z < 1$, or on naming errors, $z = -1.59$, ß $= -1.18$, $p > .01$. Crucially, no significant difference was found between the related and the control condition on immediate naming latencies, $t(1131) = 1.118$, $p > .2$. Moreover, the nonsignificant difference between the two conditions ran in the direction opposite to that predicted by the full-cascaded hypothesis.

Delayed object naming

Technical errors and extreme latencies represented 8.6% and 2.5% of the data, respectively. There were virtually no naming errors (0.6%). No effects were found on technical errors, $z = 1.24$, ß $= 0.26$, $p > .02$, or on naming errors, $z = -1.26$, ß $= -2$, $p > .02$. Latencies were also reliably shorter in the delayed (462 ms) than in the immediate object-naming task (776 ms), $t(2266) = 19.15$, $p < .001$. However, mean naming latencies did not differ reliably between the related and unrelated conditions, $t(1181) < 1$.

Discussion

Experiment 2 replicated the findings of Experiment 1. A reliable PFE was found in size naming but not in object naming. Since in this experiment the size of the referent objects varied as a function of their size in the real world (i.e., "big" or "small") and not on the size on the computer screen, a perceptual size-congruency effect is unlikely (Konkle & Olivia, 2012), contrary to our

Table 4. *Mean latencies, standard deviations, and naming error rates in congruent and control conditions used in Experiment 2, in size naming and object naming*

	Congruent condition			*Control condition*		
Type of task	*Lat.*	SD	*Naming error rates (%)*	*Lat.*	SD	*Naming error rates (%)*
Size naming	622	91	1.1	635	91	1.2
Object naming						
Immediate	794	93	1.6	757	81	0.5
Delayed	461	81	0.6	463	76	0.07

Note: Lat. = latency in ms. Object naming: immediate versus delayed.

hypothesized explanation for the findings of Experiment 1. Importantly, the lack of a PFE in immediate object naming cannot be explained in terms of differences in the articulatory characteristics of the initial phonemes, since there were no reliable differences between the two experimental conditions in the delayed object-naming task.

Why did some acoustic differences in initial phonemes yield a significant advantage for related over unrelated pictures in object naming in Experiment 1 but not in Experiment 2? It must be pointed out that the two experiments did not use the same material, with the result that different words with different acoustic properties did not trigger the voice key in the same way during the delayed naming task in Experiment 2 as that triggered in Experiment 1. Indeed, a closer look at our stimuli revealed that some of the words used in Experiment 2 (in the control condition) had initial phonemes that did not appear in the words used in Experiment 1 (e.g., /d/, /f/, /l/, /o/, and /r/). It therefore remains a possibility that certain of these phonemes triggered the voice key more strongly, leading to faster delayed latencies in the control condition of Experiment 2. Another explanation is related to the use of different groups of participants across the two experiments. It is possible that the difference in congruency effects in Experiments 1 and 2 reflects modulations in the time-criterion used by the participants to initialize their responses (see Chateau & Lupker, 2003, for such an account in word naming). Anyway, as for Experiment 1, we computed corrected naming latencies of Experiment 2 by subtracting delayed naming latencies from immediate naming latencies. Once again, there was no reliable phonological facilitation effect on corrected object-naming latencies, $t(967) = 1.69$, $p > .05$. The lack of PFE in object naming cannot be explained in terms of the idea that adjective activation arrives too late to influence the phonological encoding of the object's name. Indeed, in this experiment (as in Experiment 1) the speed of object size processing was faster than that of noun retrieval. Therefore, the findings suggest that the differential effect in the size- and object-naming tasks is due to the fact that, in both tasks, only the object name is automatically phonologically encoded.

Alternatively, it could be argued that "GRAND" is indeed phonologically encoded during object naming but does not significantly affect naming latencies, maybe because the phonological codes of the object's property are less strongly activated than those of the object's identity. Thus, the hypothesis that object properties are phonologically activated cannot be definitively ruled out despite the lack of a PFE in object naming. It follows then that we should be more likely to observe the phonological activation of nontarget properties in situations where the phonological activation of the object's identity does not come into play. Experiment 3 was designed to examine this point.

EXPERIMENT 3: AGE AND COLOUR NAMING

We examined whether the phonological activation of adjectives corresponding to nontarget properties of objects can affect picture-naming latencies in a situations where the objects do not have a core identity. We ran two age- and colour-naming tasks in French. Adjectives corresponding to colours are typically postnominal in French, whereas adjectives corresponding to the age of a person or to the age of an object are typically pronominal (e.g., *un **jeune** homme*–a young man). Participants had to name aloud either the age of coloured unknown faces (e.g., JEUNE, *young*, or VIEUX, *old*) or the colour of the ink in which the faces were depicted (e.g., JAUNE, *yellow*, or VERT, *green*). As mentioned above, it is likely that the phonological activation of nontarget properties is masked by the mandatory phonological activation of the identity of objects. Because unknown faces do not possess a core identity for the participants tested in the experiment, the probability of observing phonological activation of nontarget properties (i.e., the face's colour) should increase. If nontarget properties can spread activation to the phonological level, a PFE should be observed both in colour naming and in age naming (e.g., JEUNE should be phonologically activated when naming JAUNE and vice versa). However, following

Janssen et al. (2008), a PFE would be more likely in colour naming than in age naming because pronominal adjectives (i.e., relating to age) receive more activation than postnominal ones (i.e., colour).

Method

Participants

Fifty undergraduate students at Pierre Mendes-France University participated in experiment in exchange for course credits. All of them had normal or corrected-to-normal vision, and none reported any difficulties in colour perception. Participants were seated at approximately 70 cm from the computer screen.

Stimuli

Thirty faces of unknown adults (all Caucasian faces) were selected from Minear and Park's (2004) database. Only male faces were selected to avoid the use of adjectives marked for grammatical gender, (i.e., "vieille", the feminine form of the adjective old). Half of them were young adult faces ($M = 20.7$ years; $SD = 1.45$), and the remaining half were old adult faces ($M = 74.7$ years; $SD = 3.89$). Each face was resized in a 20-cm square (while respecting the real proportions of the face). The 30 pictures were then coloured yellow (85, 0, 127) or green (85, 127, 127) using the CIE Lab colour space of Photoshop CS5. Luminosity was held constant across colours. Overall, 60 experimental stimuli were created. There was a phonological relationship between the colour adjective and the age of the face for the young faces coloured in yellow (i.e., French adjectives JEUNE and JAUNE, share both the first phoneme /ʒ/ and the last phoneme /*n*/). This was also the case for the old faces coloured green (i.e., "vieux" and "vert" share the initial phoneme /*v*/). These pictures are referred to as "congruent pictures" below. In contrast, the young faces coloured green and the old faces coloured yellow, for which there was no phonological relationship between age and colour, served as control pictures. Finally, a filler condition was created in which the 15 young faces and 15 old faces were coloured in red (85, −128, 127).

Apparatus

The presentation and the randomization of the stimuli were controlled by E-prime 2.0.8.22 (Schneider, Eschman, & Zuccolotto, 2002), running on a Dell Latitude E5500 computer. The stimuli were displayed on a ProLite LCD Monitor. Naming latencies were recorded with a Sennheiser E845 microphone connected to the computer via the E-prime SR Box (Schneider, 1995).

Procedure

The participants were tested individually in a quiet room. Before the beginning of the naming experiment, there was a familiarization phase consisting of the presentation of the 30 faces in black-and-white format, with the label to use printed below (i.e., JEUNE or VIEUX—*old* or *young*, respectively). The participants were asked to pay attention to the age of the face. At the beginning of the experimental phase, half of the participants were instructed to name the ink colour in which the face was displayed without paying attention to the age of the face (i.e., colour naming), whereas the remaining half were told to name the age of face without paying attention to its colour (i.e., age naming).

The experimental phase consisted of 90 randomly presented trials. The 90 trials were divided into three blocks of 30 trials each. The presentation order of the three blocks was counterbalanced. The structure of each trial was the same as that in Experiment 1 for both age naming and colour naming. Each of the 30 faces appeared only once in each block, in yellow, green, or red. Each block consisted of 10 green pictures, 10 yellow pictures, and 10 red pictures. Red pictures were introduced as fillers in order to prevent the participants from anticipating in the colour-naming task and to limit the percentage of related trials in both tasks. Likewise, there were 10 congruent trials (e.g., young faces in yellow) per block (i.e., 5 critical pictures with young faces and 5 critical pictures with old faces). Overall, the proportion of critical trials

Table 5. *Mean latencies, standard deviations, and naming error rates in colour-naming and age-naming tasks in Experiment 3*

		Congruent pictures			*Control pictures*		
Task		*Lat.*	SD	*Naming error rates (%)*	*Lat.*	SD	*Naming error rates (%)*
Colour naming	"JAUNE"	460.2	46.7	0.6	459	46.4	0.3
	"VERT"	469.1	44.8	0.4	462.2	41.6	0.6
Age naming	"JEUNE"	478.5	51.9	0.7	482.6	52.6	0.6
	"VIEUX"	502.1	57.3	0.4	501.8	53.3	0.5

Note: Lat. = latency in ms.

was about 33%. Depending on the group, the participants named aloud either the face's colour (e.g., JAUNE, VERT, or ROUGE—*yellow*, *green*, or *red*) or age (i.e., JEUNE or VIEUX—*young* and *old*). For each task, both naming latencies and spoken responses were recorded, with the result that naming latencies could be measured by hand directly from the response spectrograms, as performed by Dumay and Damian (2011). Indeed, a null effect in both age- and colour-naming tasks might reflect a failure during naming latency recordings, rather than the absence of activation of nontarget properties (obviously, this could not be the case in object naming in Experiments 1 and 2 since a reliable effect emerged in size naming[1]). Thus, hand measurements would maximize the chances of detecting the phonological activation of nontarget properties if it occurs.

Results

Trials with technical errors, including unexpected noises in the microphone, were excluded from the analyses. Latencies associated with hesitations or with the production of a word other than the intended one (i.e., incorrect productions) were also excluded from the analysis. Finally, we applied the same exclusion criteria as those used in Experiment 1 to both colour- and age-naming tasks. Data were analysed the same way as described in Experiment 1. The statistical analyses were performed on colour- and age-naming latencies, as well as error rates. Mean latencies, standard deviations, and naming error rates are presented in Table 5.

Colour naming

There were 3.3% technical errors, 1.67% performance errors (including productions of the wrong colour and mispronunciations), and less than 0.1% extreme latencies. The analysis of performance errors revealed no reliable effect of relatedness, no effect of type of colour, and no interaction between these two factors, all $zs < 1$. In the naming latencies analyses, the type of colour was nonsignificant, $t(1423) = 1.62$, $p > .10$. Importantly, naming latencies did not differ between congruent (465 ms) and control pictures (461 ms), $t(1423) < 1$. The interaction between type of colour and type of relatedness was not significant, $t(1422) < 1$.

Age naming

One participant produced more than 20% of unusable latencies, including technical errors, performance errors, and extreme latencies, and was therefore not taken into account in the analyses. In the remaining data, there were 3.75% technical errors, 1.25% performance errors (including productions of the wrong colour and mispronunciations), and less than 0.1% extreme latencies. There were no reliable effects of type of relatedness or age, and no interaction between these two factors, either on technical errors, or on performance errors, all $zs < 1$. Age-naming latencies were shorter for the young faces (481 ms) than for the old faces

[1]Indeed, when we ran Experiments 1 and 2, we did not record the spoken responses.

(502 ms), $t(1367) = 4.59$, $p < .001$. Importantly, however, naming latencies did not differ between the congruent (490 ms) and control conditions (492 ms), $t(1367) = 0.66$. The type of relatedness and the type of colour did not interact significantly, $t(1366) = 0.79$.

Discussion

The idea underlying Experiment 3 was that the cascading of activation of nontarget properties at the phonological level should lead to PFE in colour and age naming. Our findings did not support these predictions since no reliable PFE was found in any of the tasks. Since it is always difficult to draw conclusions from null results, we ran additional Bayesian analysis, to determine the extent to which the prediction of a reliable PFE can be rejected. In effect, according to Masson (2011, p. 679) this kind of analyses "generates a graded level of evidence regarding which alternative —effect absent [null hypothesis] vs. effect present [alternative hypothesis]—is more strongly supported by the data". For both age- and face-naming tasks, the analyses revealed *positive* evidence (Raftery, 1995) in favour of the null hypothesis (i.e., absence of a PFE). Thus, if reliable PFEs were to be found, we should have been able to detect them in the age- and colour-naming latencies.

This lack of reliable PFEs could be due to the fact that nontarget properties (such as age or colour) are not phonologically encoded in colour and age naming. However, there are also alternative explanations that deserve attention. First of all, the objects (i.e., unknown faces) had no core identity but did have two salient properties (i.e., age and colour). It is possible that one of the two properties was identified and processed faster than the other. If this is the case, because their respective activations did not reach the phonological level at the same time, the phonological activation of one property did not strengthen the phonological activation of the other even when phonological segments were shared, as they were in the congruent condition. Colours were named faster (462 ms) than the age of the faces (492 ms), $t(2791) = 9.39$, $p < .001$, despite the fact that age adjectives have a higher lexical frequency than colour adjectives in French.[2] This may be due to the fact that ages are processed more slowly than colours at a perceptual level. If age processing is slower than colour processing, the phonological activation of a nontarget age may occur too late to affect the phonological activation of the target colour. Conversely, the phonological activation of a nontarget colour may occur before the phonological activation of age and could account for the absence of a PFE in both the colour- and age-naming tasks. Following this rationale, the phonological coactivation of target and nontarget properties is most likely to occur when colour processing is slow or when age processing is fast. Consequently any PFE should be particularly salient on the longest colour-naming latencies and on the shortest age-naming latencies (see Navarrete & Costa, 2005). We therefore divided the participants into "slow" and "fast" groups for analytical purposes. We did not observe a reliable Type of Relatedness × Group interaction, either in colour naming or in age naming, $t(1422) < 1$ and $t(1366) < 1$, respectively. It is therefore unlikely that the absence of a PFE in Experiment 3 is related to the visual processing speed of the two object properties.

A second possibility is that the lack of a PFE in the two tasks is due to a problem with the voice key measurements. Rastle and Davis (2002) reported that electronic voice keys often fail to reliably detect the onset of spoken words (see also Kello & Kawamoto, 1998). Thus, and following Dumay and Damian's (2011) analyses, we computed more "accurate" latencies for each naming response on the basis of manual measurements of onset taken directly from the acoustic waveform. These latencies were strongly correlated[3] with the voice key latencies

[2]Word frequencies of the French age adjectives JEUNE (270 per million) and VIEUX (257 per million) were at least three times higher than those of colour adjectives JAUNE (62 per million) and VERT (63 per million), respectively.

[3]In both tasks, the sound recordings for five participants were excluded from the manual measurements because of a failure in the recording system. Correlations between voice key latencies and hand-measured latencies were calculated on the basis of 1200 data items in each of the tasks.

discussed above in both colour naming, $r(1198) = .88$, $p < .001$, and age naming, $r(1198) = .80$, $p < .001$. There were no reliable main effects or interaction effects in any of the tasks, all ts < 1. Consequently, the most convincing account for the lack of PFE in Experiment 3 is that the phonological codes of the nontarget properties of the to-be-named item were not activated during the course of spoken word naming.

GENERAL DISCUSSION

The purpose of this study was to investigate the boundaries of the cascading flow of information from the preverbal to the phonological level in spoken object naming. Several studies have suggested that cascaded processing is limited. This implies that not all activated concepts systematically spread activation to the phonological level (e.g., Kuipers & La Heij, 2009). Indeed, the only evidence for the cascading activation of a nontarget property was provided by Janssen et al. (2008), whose study has been challenged by several experimental results. More precisely, it appears that the object's name activates its phonology even when the task only requires the naming of one of its visual properties, such as its colour (Kuipers & La Heij, 2009; Navarrete & Costa, 2005). In contrast, the name of an object's colour does not seem to be phonologically activated during object naming (Dumay & Damian, 2011; Mädebach et al., 2011). In the present study, we designed three experiments involving several naming tasks to test whether an object's properties can be processed in a cascaded fashion.

In Experiment 1, we presented pictures of objects that varied in size. The participants had to state either the size of the objects or their name. The results indicated that size naming was facilitated when there was a phonological overlap between the object's size and name (i.e., a phonological facilitation effect, PFE). The size GRAND (*big*) was named faster when the object's name was phonologically related (e.g., GORILLE, *a gorilla*) than when it was not. We accounted for this PFE in size naming in terms of a cascading process from the conceptual to the phonological level. The phonology of the object name is activated when participants have to state its size, and this favours the phonological encoding of the adjective. In contrast, object naming was not affected by this relatedness. This lack of a reliable PFE in object naming suggests that the size adjective is not phonologically encoded. These results with a new paradigm are consistent with previous findings (e.g., Dumay & Damian, 2011) and extend them to another kind of perceptual property—namely, object size. Our findings suggest that the object's identity activates its phonology while naming the object's property. However, we failed to produce evidence supporting the idea that nontarget object properties are phonologically activated during object naming. Experiment 2 ruled out the possibility that the lack of a reliable PFE in object naming in Experiment 1 was due to a size-Stroop effect arising at the perceptual level during object recognition (Konkle & Olivia, 2012). Importantly, the PFE was replicated in size naming. Taken together, the findings from Experiments 1 and 2 strongly suggest that the size of the objects (i.e., GRAND or PETIT) is not phonologically activated during object naming, and therefore they do not support the full-cascading account. Experiment 3 was designed to examine whether the phonological activation of the object name could mask the activation of the adjective. To do so, we used faces because this kind of stimulus has no core identity if the face is not familiar to the participant. The participants saw coloured faces of unfamiliar young and old men. The participants had to name either the age or the colour. No PFE emerged in any of the tasks thereby ruling out an alternative explanation in terms of different processing speeds for the visual recognition of the colour and age of the face. We believe that this pattern of findings suggests that (a) age adjectives are not phonologically encoded during colour naming, and (b) colour adjectives are not phonologically activated during age naming.

At present, we are unable to find evidence that nontarget properties (i.e., size, colour, or age) are phonologically activated during object naming. In contrast, our findings suggest that the cascading of information is limited in spoken word production with the result that object properties are not automatically processed up to the lexical level. However, although our data support a limited-cascading account of spoken object naming, we do not provide evidence that such limitations occur at a syntactic–lexical level (because of word-order constraints), as proposed by Janssen et al. (2008). Indeed, in this view, the phonology of the size adjective should be activated during object naming (Experiments 1 and 2) because, in French, size adjectives are pronominal. Thus, when phonemes are shared by the object name and adjective, the phonological encoding of the size adjective should facilitate the phonological encoding of the object name. In contrast, the phonology of the object name should not influence size naming. Stated in more operational terms, the word-order constraint hypothesis predicted a PFE in object naming but not in size naming. Note that in French, adjectives referring to the size of an object or the age of a face typically precede the noun, just as in English the colour adjectives precede the noun. Experiments 1 and 2 yielded data that do not support this hypothesis. A PFE was observed for size naming. Following the same rationale, colour naming should have been influenced by the phonological activation of the age adjectives (Experiment 3) because they are pronominal. Age naming should not be affected by the phonological activation of the colour adjectives because they are postnominal. Hence, a PFE should only be observed in colour face naming. Again, Experiment 3 did not confirm the predictions derived from the word-order hypothesis. Taken together, our findings, as well as those from previous studies (e.g., Dumay & Damian, 2011), clearly challenge Janssen and colleagues' proposal. Therefore, in single word production the restriction of the activation flow in spoken naming does not seem to be attributable to word-order constraints.

Finally, we are left with the following question. Does the size of an object play any role during object naming? The current findings strongly suggest that there is no phonological activation of the adjective corresponding to the object's size during object naming. However, they do not tell us about whether or not the size of the objects is activated at the conceptual level when the task is to name the objects. Of course, our decision to investigate the issue of whether the activation of properties of objects cascade to the lexical level in conceptually driven naming tasks was motivated by the empirical and theoretical reasons for testing this hypothesis reported in the literature (e.g., Konkle & Olivia, 2011). Importantly, Konkle and Olivia (2012) recently provided further evidence suggesting that the objects' real-world size was automatically activated at a conceptual level. Indeed, they reported a main effect of object size (big objects were recognized faster than smaller ones) suggesting that size is automatically activated at a conceptual level during object recognition (i.e., at least in a size-comparison task). However, it is important to stress that this evidence was based on experiments in which the objects' size was made particularly salient. Indeed, when the main goal is to produce the name of an object, it remains possible that object size does not play a critical role. In lexical decision, Sereno, O'Donnell, and Sereno (2009) found that object size was activated during word reading. However, Kang, Yap, Tse, and Kurby (2011) failed to find evidence in support of this hypothesis when using size ratings that were introduced as a predictor of lexical decision times taken from the English Lexicon Project (Balota et al., 2007). Indeed, size ratings did not reliably predict lexical decision times. In the light of this study, and to further assess the influence of size in object naming, we decided to collect size ratings for 207 object names from the Snodgrass and Vanderwart (1980) database for which spoken naming latencies were available (only trials having a name agreement above 75% were taken into account, see Bonin, Chalard, Méot, & Fayol, 2002, for details). Size ratings were collected from 40 additional participants who had not taken part in any of the previous experiments. They were presented with object names and had to estimate the size of each object in comparison to themselves on a 5-point scale (with 1 = "very small" and 5 = "very big"). If object size is activated during picture naming, we predicted that the bigger an object is, the faster it should be recognized. Object size should therefore be a reliable predictor of spoken picture-naming latencies. A multiple regression analysis was carried out with the spoken naming latencies taken as the dependent variable and the same set of predictors as that used by Bonin et al. (2002; i.e., AoA, lexical frequency, name agreement, image agreement, familiarity, visual complexity, image variability, number of letter, number of phonemes). The size rating scores were added in the regression equation. We found the same set of reliable predictors of naming latencies as that reported by Bonin et al. (2002). However, the effect of size was not reliable on the naming latencies. Although this finding is at odds with the findings reported by Konkle and Olivia (2012), it is consistent with the lexical decision findings presented by Kang et al. (2011). One possible explanation that might account for this discrepancy is that the conceptual activation of object size during object recognition is somewhat limited to situations in which this property is particularly *relevant* for the task in question (e.g., size comparison tasks such as those used by Konkle & Olivia, 2012). In the present study, we were unable to find evidence for the hypothesis that object size is activated at a conceptual level during object naming despite an attempt to make this property more salient in Experiment 2 by introducing a size categorization task before the naming experiment. Future studies should examine whether there are special cases where size becomes a salient property at the conceptual level and whether this information can then be encoded lexically. What seems clear at present is that nontarget object properties such as size are not phonologically encoded in object naming.

In line with previous findings (Dumay & Damian, 2011; Kuipers & La Heij, 2009; Mädebach et al., 2011), the present study provides support for a limited-cascading account of spoken word production (Bonin et al., 2012). More precisely, an object's identity cascades automatically through the lexical system, whereas object properties do not cascade to the phonological level, unless the speaker has the intention to name them. This conclusion extends to different *visual* properties of objects (i.e., size, age). However, the limitations of the cascading of activation within the lexical system still need to be established in greater detail. Thus far, cascading in spoken word production always seems to be dominated by the identity of objects (Dumay & Damian, 2011).

Original manuscript received 18 March 2013
Accepted revision received 11 July 2013
First published online 23 September 2013

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APPENDIX A.

List of picture names used in Experiment 1

"G-pictures"		*Control pictures*	
GANT	(glove)	BOUÉE	(buoy)
GARAGE	(garage)	BATTERIE	(battery)
GARÇON	(boy)	COUFFIN	(cradle)
GÂTEAU	(cake)	BAIGNOIRE	(bathtub)
GLACE	(ice cream)	TROMBONE	(trombone)
GOMME	(eraser)	TRONC	(trunk)
GORILLE	(gorilla)	ANGE	(angel)
GOURDE	(gourd)	CHÂTEAU	(castle)
GRANGE	(barn)	ÉTIQUETTE	(label)
GRAPHIQUE	(graphic)	COUTEAU	(knife)
GRENADE	(grenade)	BLÉ	(wheat)
GRENOUILLE	(frog)	MOUSTIQUE	(mosquito)
GRILLE-PAIN	(toaster)	AGRAFEUSE	(stapler)
GRUYÈRE	(cheese)	JAMBON	(ham)
GUITARE	(guitar)	ÉCLAIR	(lightning)

APPENDIX B.

List of picture names used in Experiment 2

"Related" pictures		*Control pictures*	
GALAXIE	(galaxy)	ROUE	(wheel)
GARAGE	(garage)	AMBULANCE	(ambulance)
GLACIER	(glacier)	IGLOO	(igloo)
GORILLE	(gorilla)	DINOSAURE	(dinosaur)
GOUTTIERE	(gutter)	ECHELLE	(scale)
GRANGE	(barn)	MOULIN	(mill)
GRATTE-CIEL	(skyscraper)	FUSEE	(rocket)
GRILLAGE	(mesh)	HARPE	(harp)
GROTTE	(cave)	TUNNEL	(tunnel)
GRUE	(crane-construction)	ANCRE	(anchor)
PANIER	(basket)	CAGE	(cage)
POING	(fist)	CASQUE	(helmet)
PLAT	(dish)	CHAT	(cat)
PIED	(foot)	BRAS	(arm)
POISSON	(fish)	COUTEAU	(knife)
PANTALON	(pants)	TELEPHONE	(telephone)
POMME	(apple)	FLEUR	(flower)
POT	(pot)	OS	(bone)
POUCE	(thumb)	CRANE	(crane)
PAPILLON	(butterfly)	ROBINET	(tap)
PORTEFEUILLE	(wallet)	MICROSCOPE	(microscope)
POULET	(chicken)	CITRON	(lemon)
PINCEAU	(brush)	BRIQUET	(lighter)
PEIGNE	(comb)	SIFFLET	(whistle)
PERROQUET	(parrot)	ECUREUIL	(squirrel)
POUSSIN	(chick)	LEZARD	(lizard)
PINGOUIN	(penguin)	SCORPION	(scorpion)
POIREAU	(leek)	ARTICHAUT	(artichoke)
POIVRON	(pepper)	BONBON	(candy)