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From the Bob/Kirk effect to the Benoit/Éric effect: Testing the mechanism of name sound symbolism in two languages

David M. Sidhu [a,*], Penny M. Pexman [a], Jean Saint-Aubin [b]

[a] University of Calgary, Canada
[b] Université de Moncton, Canada

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ABSTRACT

Although it is often assumed that language involves an arbitrary relationship between form and meaning, many studies have demonstrated that nonwords like *maluma* are associated with round shapes, while nonwords like *takete* are associated with sharp shapes (i.e., the Maluma/Takete effect, Köhler, 1929/1947). The majority of the research on sound symbolism has used nonwords, but Sidhu and Pexman (2015) recently extended this effect to existing labels: real English first names (i.e., the Bob/Kirk effect). In the present research we tested whether the effects of name sound symbolism generalize to French speakers (Experiment 1) and French names (Experiment 2). In addition, we assessed the underlying mechanism of name sound symbolism, investigating the roles of phonology and orthography in the effect. Results showed that name sound symbolism does generalize to French speakers and French names. Further, this robust effect remained the same when names were presented in a curved vs. angular font (Experiment 3), or when the salience of orthographic information was reduced through auditory presentation (Experiment 4). Together these results suggest that the Bob/Kirk effect is pervasive, and that it is based on fundamental features of name phonemes.

1. Introduction

1.1. Arbitrariness, sound symbolism and the Maluma/Takete effect

The notion that language is arbitrary has long been considered one of its defining features (Hockett, 1963; Saussure, 1916; for a review, see Perniss, Thompson, & Vigliocco, 2010). According to this view, there is no a priori reason for any meaning to be denoted by any particular set of phonemes. Thus there is nothing restricting the pairing of words and meaning, and no requirement that the features of words—or the phonemes they contain—reflect their meaning. Because of this, small words like *sky* can denote big things, while large words like *Parastratiosphecomyia sphecomyioides* can denote small things (a type of fly). Further evidence for arbitrariness comes from the fact that a word like *tree*—without any tree-like features—can nevertheless denote the concept tree. Moreover, different languages can denote this same concept with entirely different word forms (e.g., *tree* is translated to *arbre* in French, and *fa* in Hungarian). In fact, there is some evidence from computational modeling studies that arbitrariness within a lexicon is beneficial (Gasser, 2004; Monaghan, Christiansen, & Fitneva, 2011).

While there may not be a requirement for the features of words to reflect their meaning, there is a good deal of evidence that certain phonemes can seem to be a better match for certain kinds of meanings than others. Sound symbolism is a phenomenon in which the features of phonemes reflect, and thus lead to an association with, particular meanings. Perhaps the most well documented example of this is the Maluma/Takete effect, first alluded to by Köhler (1929, 1947). Köhler suggested that nonwords such as *maluma* seem to be inherently associated with roundness, while others such as *takete* seem to be associated with sharpness (See Fig. 1). Holland and Wertheimer (1964) demonstrated this experimentally some years later when they found that participants indeed rated *maluma* as being extremely rounded, and *takete* as being extremely angular. More recently, Ramachandran and Hubbard (2001) investigated the effect using the nonwords *bouba* and *kiki*; they found that when shown a round and sharp shape, 95% of their participants paired *bouba* with the round shape, and *kiki* with the sharp shape. These findings suggest that some features of the phonemes in *maluma*/*bouba* and *takete*/*kiki* are associated with roundness and sharpness, respectively.

The Maluma/Takete effect also extends beyond a few carefully chosen nonwords. Studies have demonstrated that the consonant phonemes /b/, /l/, /m/ and /n/ all seem to be associated with roundness, while /k/, /p/ and /t/ seem to be associated with sharpness (Maurer, Pathman, & Mondloch, 2006; Nielsen & Rendall, 2011). Thus in general sonorant consonants are associated with roundness, while

* Corresponding author at: Department of Psychology, University of Calgary, 2500 University Drive NW, Calgary, AB, T2N1N4, Canada.
E-mail address: dsidhu@ucalgary.ca (D.M. Sidhu).

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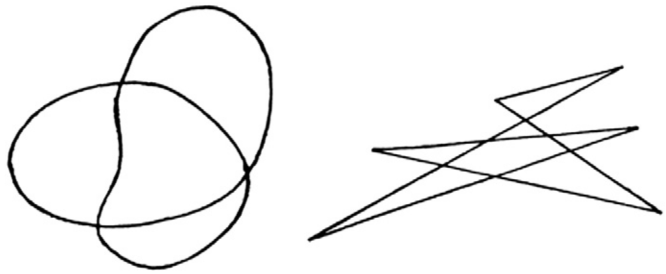

Fig. 1. Reproductions of Köhler's (1929, 1947) original stimuli. He suggested that *maluma* would be associated with the shape on the left, and that *takete* would be associated with the shape on the right.

obstruents—and in particular voiceless stops—are associated with sharpness. An exception to this pattern is the voiced stop /b/, which has demonstrated an association with roundness despite being an obstruent. It may be that the particular combination of being voiced, and articulated bilabially, leads to its association with roundness (see D'Onofrio, 2013, for a discussion of this topic). In terms of vowels, /u/ and /o/ (and to a lesser extent /ɒ/) are associated with roundness, while /i/, /eɪ/ and /ə/ are associated with sharpness (Maurer et al., 2006; Nielsen & Rendall, 2011). Therefore, rounded vowels show an association with roundness while unrounded vowels show an association with sharpness.

There is also evidence that the Maluma/Takete effect generalizes to speakers of languages besides English. Davis (1961) demonstrated the effect in school children from the Mahali peninsula of Lake Tanganyika, on the Congo-Tanganyika border, using the nonwords *uloomu* and *takete*, presented both visually and auditorily. These children both spoke and were educated in Swahili. Similarly, Bremner et al. (2013) studied the effect in the Himba tribe of Northern Namibia, a group known for their remoteness from outside cultural influence. Members of the Himba tribe speak Otjiherero but have no written language, and so the stimuli were presented auditorily. Nevertheless they too showed the association between the nonwords *bouba* and *kiki*, and round and sharp shapes, respectively. These results suggest that the Maluma/Takete effect is a general phenomenon, observable across a variety of diverse cultures.

Despite the generalizability of the Maluma/Takete effect across cultures, it has primarily been studied with nonwords (e.g., Maurer et al., 2006; Ramachandran & Hubbard, 2001). In terms of patterns in existing lexicons, there has been no substantial evidence that round-sounding (or sharp-sounding) phonemes are more common in words with meanings related to roundness (or sharpness). Monaghan, Mattock, and Walker (2012) compared the phonemes in English words related to curvature vs. angularity, and found only a few small differences. Similarly, studies using a lexical decision task have revealed little evidence that this association can affect responses to real words on behavioural measures (Sučević, Janković, & Ković, 2013; Sučević, Savić, Popović, Styles, & Ković, 2015; Westbury, 2005). Those results seem to suggest that real words, with learned meanings, might somehow be processed differently than nonwords like *bouba* and *kiki* (Westbury, 2005). It may be that real words' existing semantic content overshadows any meaning that may be sound symbolically associated with their phonemes.

To approach this issue, Sidhu and Pexman (2015) examined the Maluma/Takete effect in a specific set of real words: first names. This was a way of testing if effects would emerge for words with some associated information. That is, while names can't be said to have associated semantics, they are assumed to have associated episodic information (Cohen & Faulkner, 1986). Thus they are somewhat of an intermediary between nonwords and real words. If words with any existing associations are somehow processed differently, precluding congruency effects from arising, then they should not emerge for real first names. The Sidhu and Pexman study used phonemically round (e.g., *Bob* and *Molly*) and phonemically sharp (e.g., *Kirk* and *Kate*) male and female names. On each trial, participants were visually presented with a single name along with a round and sharp silhouette, and asked to choose the silhouette that the name best suited. Results indicated that participants were more likely to associate phonemically round (or sharp) names with round (or sharp) silhouettes. In addition to this 'Bob/Kirk effect', participants were also more likely to associate male names with sharp silhouettes, and female names with round silhouettes. So far, this effect has only been demonstrated in English. The purpose of the present study was to test the generalizability of the Bob/Kirk effect to another language (French names and French speakers), and to further investigate the mechanism underlying it.

1.2. The roles of phonology, articulation and orthography in the Maluma/Takete effect

Despite the long history of the Maluma/Takete effect, its underlying mechanism remains a subject of debate. The phonological/articulatory explanation is that the Maluma/Takete effect arises out of a crossmodal association between these features of the phonemes and the visual features of the shape stimuli. That is, on the one hand, the consonant phonemes in sharp-sounding nonwords such as *takete* consist of abrupt changes in sound, and are articulated with abrupt movements of the tongue. On the other hand, the consonant phonemes in round-sounding nonwords such as *maluma* involve relatively more continuous sounds, as well as less punctuated articulations. In addition, the vowel phonemes in round-sounding nonwords are typically articulated with a rounding of the lips (e.g., /u/ or /o/). In both cases, these features of sharp- and round-sounding nonwords' phonemes resemble the visual features of the shapes they are associated with (i.e., abrupt changes in direction, or continuous smooth curves). Some have suggested that this association may be a sort of "weak synesthesia" that arises out of connections between brain areas responsible for processing stimuli in these different modalities (Ramachandran & Hubbard, 2001). Others have suggested that it may emerge after observing these kinds of stimuli co-occurring in the world numerous times (e.g., visually round objects feeling softer; Spence, 2011).

However, an alternate explanation is that the Maluma/Takete effect arises out of a similarity between the orthography of typically round-sounding nonwords and round shapes, and typically sharp-sounding nonwords and sharp shapes (Cuskley, Simner, & Kirby, 2015). That is, nonwords such as *bouba* contain predominantly rounded letters, while nonwords such as *kiki* contain predominantly angular letters. Thus, it may be that participants simply match the visual appearance of a given nonword with a candidate shape. The fact that the phonological and articulatory features of phonemes are often confounded with their orthography has made these two possibilities difficult to untangle.

Several of the previously mentioned studies showing generalization of the Maluma/Takete effect have been put forth as evidence against an explanation based in orthography. For instance, the finding reported by Bremner et al. (2013), that non-English speaking individuals without a writing system show the Maluma/Takete effect, demonstrates that it can emerge even in the absence of orthography. Also pointing to this conclusion is a study by Ozturk, Krehm, and Vouloumanos (2013), in which there was evidence of the Maluma/Takete effect in the looking times of four-month-old infants. A study by Nielsen and Rendall (2011) attempted to control for the orthographic roundness of letters such as *m* and *n* by presenting these letters in their capitalized form (*M* and *N*). Even though round-sounding nonwords no longer had relatively rounder orthographies, participants still showed the typical Maluma/Takete effect. Lastly, a study by Westbury (2005) used more implicit methodology, and demonstrated that participants were faster to process round- or sharp-sounding letters if they were presented inside of congruent frames (i.e., rounded or angular, respectively). However participants were no quicker to process visually-round or visually-sharp letters inside of congruent frames. These studies suggest that features of the nonwords beyond their orthography (i.e., their phonology and/or articulation) are the main contributors to the Maluma/Takete effect.

However, in a recent review of the literature, Cuskley et al. (2015) argued that this matter is far from settled, and that there is a good deal of contradictory evidence. To begin, the study by Bremner et al. (2013) was limited to only two nonwords; in addition, at least one study has failed to find evidence of the Maluma/Takete effect in a non-English speaking population (Rogers & Ross, 1975). Also, while the findings of Ozturk et al. (2013) are compelling, a study using a larger sample size failed to replicate the effect in infants of the same age (Fort, Weiß, Martin, & Peperkamp, 2013).

In their recent study, Cuskley et al. (2015) directly tested the role of orthography in the Maluma/Takete effect by varying the phonology (voiced vs. unvoiced; characteristics shown to be associated with round and sharp shapes, respectively, D'Onofrio, 2013) and visual appearance (orthographically round vs. sharp) of their nonword stimuli in a fully crossed design. Using both visual and auditory presentation, they found that the visual appearance of the nonwords was a better predictor of their association with round and sharp shapes, than was the phonology of the nonwords. That is, even though voiced consonants have shown an association with round shapes, a nonword such as *zeze* (i.e., one with voiced consonants and a sharp orthography) was more associated with sharp shapes than round shapes. This suggests that orthography may play a larger role than phonology in certain sound symbolic effects; orthography determined pairings more than phonology when these factors were placed in direct competition.

1.3. The present study

Our goals for the present study were twofold: 1) to test whether the sound symbolic effects for first names reported by Sidhu and Pexman (2015; the Bob/Kirk effect) extend to another language: French speakers and French names, and 2) to investigate the mechanism at work in the Bob/Kirk effect; that is, the relative contributions of phonology and orthography. As noted, the past studies have been equivocal regarding the mechanism of sound symbolic effects in nonword stimuli. Thus, it is necessary to examine the mechanism at work when utilizing real labels (i.e., first names). In fact, studies on brand names have suggested that orthography can moderate the sound symbolic effects of invented product labels (e.g., Doyle & Bottomley, 2011). Furthermore, there is evidence that orthography can play a different role in the processing of existing words as compared to nonwords (e.g., Montani, Facoetti, & Zorzi, 2014; Moret-Tatay & Perea, 2011). While phonological decoding is especially important in the processing of nonwords (Dietz, Jones, Gareau, Zeffiro, & Eden, 2005), it may be less important to the processing of first names with which participants are already familiar.

In Experiments 1 and 2 we tested the generalizability of the Bob/Kirk effect to French-English bilinguals and French names, and did so using a wide variety of stimuli (cf. Bremner et al., 2013; Davis, 1961; Rogers & Ross, 1975). That is, we attempted to replicate the effects observed by Sidhu and Pexman (2015) in French-English bilinguals using both English (Experiment 1) and French (Experiment 2) names. Then, in Experiments 3 and 4, we examined sound symbolic associations for English and French names, across both English and French speaking populations. In doing so, we examined the extent to which familiarity with the names modulated the Bob/Kirk effect, since French-English bilinguals were more familiar with French names and English speakers were more familiar with English names.

To investigate the mechanism underlying the Bob/Kirk effect, we directly assessed the respective roles of orthography and phonology. In Experiment 3, using visual presentation, we contrasted fonts that consisted of round vs. sharp features. If the effect is based in orthography, then font should have an effect on the associations observed. If, in contrast, the effect is based in phonology then font should not affect the associations observed. Finally, in Experiment 4, we used auditory presentation to examine if the Bob/Kirk effect would emerge when the salience of orthographic information was reduced. If the effect is based in orthography then it should be reduced by auditory presentation, but if the effect is based in phonology then it should not be reduced.

2. Experiment 1

In Experiment 1 we examined whether French-speaking students at the Université de Moncton show a Bob/Kirk effect; that is, associating round-sounding (or sharp-sounding) English names, and female (or male) English names, with round (or sharp) silhouettes. While 60% of Moncton residents report English as their mother tongue, 52% of the population speaks French, with 35% claiming it as their mother tongue (Statistics Canada, 2011a). In addition, the Université de Moncton is a French-language university. This was an exact replication of Experiments 1a and 1b conducted by Sidhu and Pexman (2015), but with French speaking participants. This also allowed us to examine if the Bob/Kirk effect would emerge when participants viewed names that were less familiar, a potential factor in sound symbolic effects with real words (Westbury, 2005).

2.1. Method

2.1.1. Participants

Participants were 30 undergraduate students (24 female; *M* Age = 18.40, *SD* = 0.77) at the Université de Moncton who received course credit. All participants reported French fluency and normal or corrected to normal vision. Note that while these participants were fluent in French, and were attending a French language university, because Canada is a bilingual country many of them likely also spoke English. Thus they are referred to here and throughout as French-English bilinguals.

2.1.2. Materials and procedure

Materials and procedure were identical to those used by Sidhu and Pexman (2015). Based on previous literature (Maurer et al., 2006; Nielsen & Rendall, 2011) the consonant phonemes /b/, /l/, /m/ and /n/ were considered round-sounding, while /k/, /p/ and /t/ were considered sharp-sounding. Similarly, the vowels /u/, /o/ and /ɒ/ were considered round-sounding. Sidhu and Pexman selected five round-sounding male and five round-sounding female names that contained at least one round-sounding consonant phoneme and no sharp-sounding consonant phoneme, and at least one round-sounding vowel phoneme. They also selected five sharp-sounding male names and five sharp-sounding female names that contained at least one sharp-sounding consonant phoneme and no round-sound consonant phonemes, and no round-sounding vowel phonemes. Note that in terms of their vowels, names were categorized based on the presence or absence of round vowels; this is because while vowels can be round, they cannot be sharp. See Table A.1 for a full list of name stimuli

Sidhu and Pexman (2015) consulted the Alberta database of baby names to ensure that the round- and sharp-sounding names, and female and male names, did not differ in terms of their frequency per million people in Alberta (see Table A.1 for the complete list of names used and the following address for the norms http://open.alberta.ca/dataset/frequency-and-ranking-of-baby-names-by-year-and-gender). For present purposes, we also ran a norming pilot study to assess subjective familiarity for the names. Thirty French-English bilingual participants from the Université de Moncton, and thirty English-speaking participants from the University of Calgary, who did not take part in any of the current experiments, rated the names used in this and subsequent experiments in the current article in terms of their familiarity. Names were rated on a scale from 1 (very unfamiliar) to 7 (very familiar). We included participants from both populations to assess the relative familiarity of the names in different language settings. Calgary is largely an English-speaking city, with 69% claiming English as their mother tongue. Importantly, only 7% of Calgarians speak French (Statistics Canada, 2011b). In addition, the University of Calgary is an

Table 1
Québec and Alberta baby name frequencies per million people and mean subjective familiarity ratings collected in Moncton, for name stimuli used in Experiment 1.

	Name type			Name gender		
	Round	Sharp	*p*	Female	Male	*p*
Québec baby name frequency per million	0.72 (0.81)	0.82 (1.74)	0.88	1.13 (1.76)	0.38 (0.50)	0.24
Alberta baby name frequency per million	3.32 (4.38)	3.67 (5.36)	0.88	3.02 (4.22)	3.97 (5.45)	0.67
Mean Moncton subjective familiarity rating	2.82 (1.34)	2.18 (1.64)	0.35	3.15 (1.64)	1.85 (1.05)	0.05

Note. Québec baby name frequency for English names does not include Leo.

English-language university. With regards to the present experiment, results of the normative study revealed that our round- and sharp-sounding names did not differ in terms of their subjective familiarity to raters in Moncton. However, female names were moderately more familiar than male names to raters in Moncton. Because the purpose of the present study was a direct replication of Sidhu and Pexman (2015), we nevertheless proceeded with the items (see Table 1).

We next compared the frequency of these names in the Alberta norms to their frequency in the Quebec baby name norms (available at http://www.rrq.gouv.qc.ca/fr/enfants/banque_prenoms/Pages/banque_prenoms.aspx), to ensure that they were indeed less familiar to the French-English bilingual population studied here than the English-speaking population studied by Sidhu and Pexman (2015). We selected the Québec database because Québec is the Canadian province with the largest French speaking population, with 6.2 million reporting French as their mother tongue. It is also the only province in which French speakers form the majority of the population (about 80%) (Statistics Canada, 2011c). To correct for the differences in population size between Alberta and Quebec, names were compared based on their frequency per million people in each province (population statistics are available at http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/cst01/demo02a-eng.htm). Note that this analysis excluded the name Leo, because Leo with an acute accent on the *e* (Léo) is a French name, while it is an English name without accent, with a distinct pronunciation. Unfortunately, the Québec database does not consider accents and provides a single frequency rating for Leo and Léo. As expected, paired samples t-tests indicated that the English names used in this experiment were significantly more common in the Alberta norms ($M = 3.07$, $SD = 4.51$) than in the Quebec norms ($M = 0.78$, $SD = 1.34$), $t(18) = 2.66$, $p = 0.016$. In addition, pilot participants in Calgary rated all of the names as being significantly more subjectively familiar ($M = 3.09$, $SD = 1.58$) than did the raters in Moncton ($M = 2.50$, $SD = 1.50$), $t(19) = 2.67$, $p = 0.015$.

The shape stimuli consisted of 20 pairs of alien-like character silhouettes. Each pair of silhouettes was created from a single source that was

Fig. 2. Examples of round silhouette stimuli (left) and sharp silhouette stimuli (right).

traced with either a wavy (for the round silhouette) or jagged (for the sharp silhouette) outline. Both members of the pair were then filled with the same solid fill of red, green, orange or blue (see Fig. 2).

The instructions were the same as those used in Sidhu and Pexman (2015) Experiments 1a and 1b, except that here they were presented in French. As such, participants were told that on each trial they would see a pair of aliens who had just arrived on Earth, and that to facilitate integration into society the aliens needed to be given names. On each trial participants were shown a pair of alien silhouettes, one on the left side of the screen and one on the right, along with a single name presented in the bottom centre of the screen, and were asked to choose the alien that the name best suited. Stimuli remained onscreen until participants made a response via button press, after which there was a 500 ms blank screen between trials. Participants were given one practice trial, followed by 20 trials in the experiment proper. The pairing between names and silhouettes, as well as the side of the screen on which a particular silhouette appeared, was counterbalanced across participants.

2.2. Results

There have been concerns raised about the use of ANOVAs when analyzing categorical count data (see Jaeger, 2008, for a discussion of this). In particular, when the outcome measure involves a series of dichotomous decisions (in this case, whether a name was paired with a round or sharp silhouette), conducting an ANOVA on the proportion of responses in a particular direction may violate the assumptions of normality and homogeneity of variance; additionally, its computation can also involve predictions that fall outside of what is observable in reality (Seltman, 2015). As an alternative, Jaeger (2008) recommends a logistic regression, which uses a logistic function as opposed to a linear one, a better fit for categorical count data.

We examined the effects of name gender (male vs. female) and name type (sharp-sounding vs. round-sounding) on shape selection with a mixed effects logistic regression in which the dependent variable was whether or not the round silhouette was selected. All mixed effects analyses were conducted using R (version 3.1.2; R Development Core Team, 2010). The data were analyzed by entering all trials into the logistic regression, with each trial receiving a "0" on the dependent variable if the participant chose the sharp silhouette, and a "1" if the participant chose the round silhouette. The particular subject and item that contributed to any given trial were modeled as random intercepts; these were included in all models unless their variance was equal to 0.00, in which case they were removed. Name gender and name type were dummy coded such that male names and sharp-sounding names were treated as reference categories. Thus, this logistic regression predicted the probability of choosing a round silhouette, for female names as opposed to male names, and round- as opposed to sharp-sounding names. Here and in subsequent experiments we used this model as a starting point to then also examine the inclusion of other potential predictors. This was done by comparing the χ^2 values of two models that were identical save for the predictor(s) being evaluated. The *p* value of the difference was then determined based on the χ^2 distribution.

Results of Experiment 1 indicated that participants were 2.10 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 3.95$, $p < 0.001$) and 1.92 times more likely when presented with a round-sounding name than a sharp-

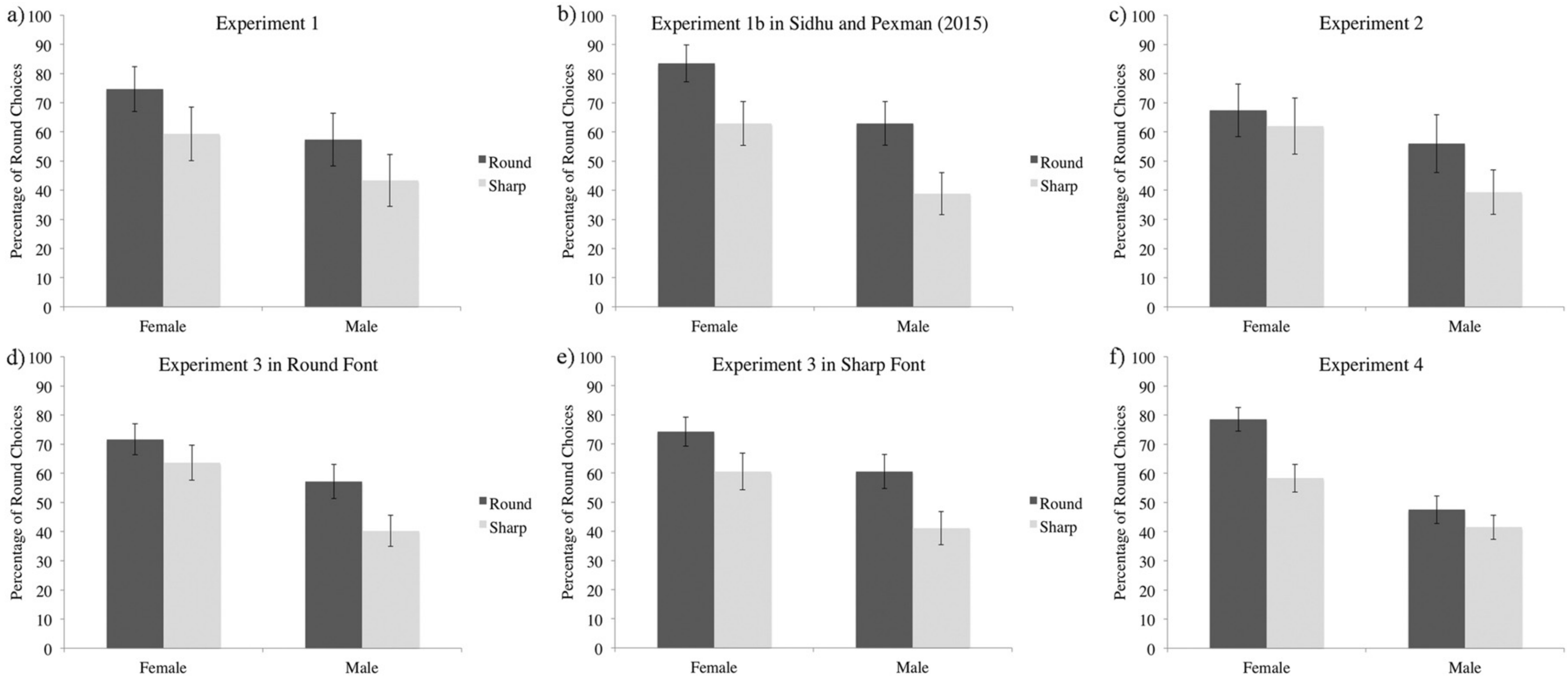

Fig. 3. Percentage of Round Choices by Name Type and Gender in: a) Experiment 1, b) Experiment 1b of Sidhu and Pexman (2015), c) Experiment 2, d) Experiment 3 when presented in a round font, e) Experiment 3 when presented in a sharp font, and f) Experiment 4. Error bars reflect 95% confidence intervals computed using the method outlined by Cousineau (2005) to remove between-subject variability.

Table 2
Summary of logistic regression analysis in Experiment 1.

Fixed effect	Coefficient	*SE*	Wald *Z*	*p*
Intercept	−0.31	0.17	−1.80	0.07
Name gender	0.74	0.19	3.95	<0.001***
Name type	0.65	0.19	3.50	<0.001***
Random effect				s^2
Subject intercept				0.15
Item intercept				0.02

N = 600; log-likelihood = −389.11; AIC = 788.21.
*** *p* < 0.001.

sounding name (Wald $Z = 3.50$, $p < 0.001$), see Fig. 3a. For a summary of the model, see Table 2. This model was compared to one also including an interaction between name gender and name type, however including this as a predictor did not significantly improve model fit, $\chi^2(1) = 0.14$, $p = 0.71$. Note that the statistical software automatically computed the interaction terms used in this and subsequent analyses.

A supplementary analysis examined if name frequency (according to the Alberta baby name database) affected the likelihood of making a congruent pairing. We examined the effect of name frequency with a mixed effects logistic regression in which the likelihood of making a congruent pairing (i.e., selecting the round silhouette for a round-sounding name) was the dependent variable. Name frequency was mean centred prior to analysis to facilitate interpretation of the intercept. We compared a model including only random subject and item intercepts to one also including name frequency. Including frequency as a predictor did not significantly improve model fit, $\chi^2(1) = 0.00$, $p = 0.98$. We reran this analysis to ensure that results did not differ when using names' subjective familiarity instead of frequency. It was discovered that including subjective familiarity to Moncton raters did not significantly improve model fit, $\chi^2(1) = 0.03$, $p = 0.87$. Consequently, for the remaining analyses, we only report results with frequency.

Finally, in order to further examine the ubiquity of the Bob/Kirk effect, we compared these results to those of Experiment 1b in Sidhu and Pexman (2015). Experiment 1b from Sidhu and Pexman (2015) followed the same procedure as the one reported here except that it included only English-speaking participants from the University of Calgary (see Fig. 3b). Examining both datasets together, results indicated that participants were 2.49 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 5.54$, $p < 0.001$) and 2.38 times more likely when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 5.28$, $p < 0.001$). We next examined whether these effects varied by location (Université de Moncton vs. University of Calgary) with interaction terms that included a location factor. Here and in subsequent experiments, interactions were tested separately by model comparisons. That is, we tested each interaction by comparing the χ^2 values of a model including only main effects, and all lower level interactions, to one also including the interaction of interest. By this approach, we found that including the three-way interaction between name gender, name type and location did not significantly improve model fit, $\chi^2(1) = 0.01$, $p = 0.93$. Likewise an analysis of the relevant two-way interactions found that including the two-way interaction between name gender and location did not significantly improve model fit, $\chi^2(1) = 1.48$, $p = 0.22$; nor did including the two way interaction between name type and name language, $\chi^2(1) = 2.54$, $p = 0.11$.

2.3. Discussion

The results of the present Experiment 1 replicate those of Sidhu and Pexman (2015) and provide further evidence that sound symbolism extends to existing labels in the form of the Bob/Kirk effect. Despite the fact that first names carry some existing associations, the sound symbolic properties of the phonemes they contain impact the meaning participants associate with them. Participants paired names containing round-sounding (or sharp-sounding) phonemes with round (or sharp) silhouettes. In addition, participants were more likely to associate female (or male) names with round (or sharp) silhouettes. Notably, this was observed in a French-English bilingual population, suggesting that these effects generalize beyond English speakers. Although these names were likely to have been less familiar for French-English bilingual participants, we observed a reliable Bob/Kirk effect. There was also no evidence that the effects differed from those observed in an English-speaking population by Sidhu and Pexman (2015).

3. Experiment 2

Experiment 1 clearly established the presence of sound symbolic effects of English first names in a French-speaking population. We next tested the Bob/Kirk effect with French names and a French-speaking population.

3.1. Method

3.1.1. Participants

Participants were 30 undergraduate students (24 female; *M* Age = 20.03, *SD* = 2.65) at the Université de Moncton who received course credit. All participants reported French fluency and normal or corrected to normal vision.

3.1.2. Materials and procedure

The shape stimuli and the procedure were identical to those described for Experiment 1. In this experiment the name stimuli consisted of round- and sharp-sounding French names, selected in the same manner as in Experiment 1. Five names contained both round- and sharp-sounding consonant phonemes (i.e., *Alec*, *Alexi*, *Alexi*, *Alix*, and *Malika*); in these cases the names were categorized based on the identity of the *final* round- or sharp-sounding consonant phoneme they contained. See Table A.2 for a full list of name stimuli. We ensured that round- and sharp-sounding names, and female and male names, were equally common in the Quebec baby name database, and equally familiar to Moncton raters from the norming study (see Table 3).

3.2. Results

We examined the effects of name gender (male vs. female) and name type (sharp-sounding vs. round-sounding) on shape selection with a mixed effects logistic regression in which the dependent variable was the likelihood of selecting the round silhouette. Name gender and name type were dummy coded such that male names and sharp-

Table 3
Québec baby name frequencies per million people and mean subjective familiarity ratings collected in Moncton, for name stimuli used in Experiment 2.

	Name type			Name gender		
	Round	Sharp	*p*	Female	Male	*p*
Québec baby name frequency per million	3.90 (2.32)	4.01 (2.59)	0.92	3.47 (2.85)	4.44 (1.86)	0.22
Alberta baby name frequency per million	1.72 (2.29)	1.70 (2.25)	0.98	1.17 (1.82)	2.25 (1.52)	0.29
Mean Moncton subjective familiarity rating	4.85 (1.11)	4.47 (1.50)	0.53	4.30 (1.44)	5.02 (1.09)	0.38

Table 4
Summary of logistic regression analysis in Experiment 2.

Fixed Effect	Coefficient	*SE*	Wald *Z*	*p*
Intercept	−0.34	0.16	−2.06	0.04*
Name Gender	0.73	0.17	4.26	<0.001***
Name Type	0.48	0.17	2.80	0.005**
Random effect				s^2
Subject intercept				0.16

$N = 600$; log-likelihood = −396.13; AIC = 800.26.
* $p < 0.05$,
** $p < 0.01$
*** $p < 0.001$.

sounding names were treated as reference categories. Item intercept variance was equal to 0.00 and so the random item intercept term was removed.

Results indicated that participants were 2.08 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 4.26$, $p < 0.001$) and 1.62 times more likely when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 2.80$, $p = 0.005$), see Fig. 3c. For a summary of the model, see Table 4. This model was compared to one including an interaction between name gender and name type, however including this predictor did not significantly improve model fit, $\chi^2(1) = 1.79$, $p = 0.18$.

A supplementary analysis examined if name frequency (according to the Québec baby name database) affected the likelihood of making a congruent pairing. We examined the effect of name frequency with a mixed effects logistic regression in which the likelihood of making a congruent pairing was the dependent variable. Name frequency was mean centred prior to conducting the analysis. We compared a model including only random subject and item intercepts to one also including frequency. Including frequency as a predictor did not significantly improve model fit, $\chi^2(1) = 0.01$, $p = 0.92$.

3.3. Discussion

The results of Experiment 2 were much the same as those of Experiment 1, and thus show generalization of the Bob/Kirk effect to French names. Participants were more likely to pair round-sounding (or sharp-sounding) French names, and female (or male) French names, with round (or sharp) silhouettes. This demonstrates that the impact of the sound symbolic properties of phonemes in existing labels is not restricted to English names.

4. Experiment 3

In Experiment 3 we directly examined the role of orthography in the Bob/Kirk effect. While there have been findings which suggest that the Maluma/Takete effect can emerge in the absence of orthographic information (e.g., Bremner et al., 2013; Ozturk et al., 2013), the evidence has been equivocal (Fort et al., 2013; Rogers & Ross, 1975). In addition, there is recent evidence that orthography can play a larger role than voicing in nonword-shape pairings (Cuskley et al., 2015), and can moderate sound symbolic effects with invented labels (Doyle & Bottomley, 2011). Finally, unlike previous studies, the Bob/Kirk effect involves existing words; there is evidence that orthography can play a different role in the processing of real words and nonwords (Montani et al., 2014; Moret-Tatay & Perea, 2011).

In order to test the role of orthography in the Bob/Kirk effect, we conducted a straightforward test of the role of names' visual appearance in sound-symbolic associations, by directly manipulating the visual-roundness and visual-sharpness of the letters presented. This allowed us to investigate the phonemes that are typically associated with roundness and sharpness, and observe if these associations would persist when orthography was manipulated. In addition, we again examined the role of familiarity with the name stimuli by presenting both French and English names to participants from French- and English-speaking populations.

4.1. Method

4.1.1. Participants

Participants were 30 undergraduate students (21 female; *M* Age = 20.53, *SD* = 1.66) at the Université de Moncton reporting French fluency, and 30 undergraduate students (14 female; *M* Age = 21.43, *SD* = 3.73) at the University of Calgary reporting English fluency. All participants received course credit and reported normal or corrected to normal vision.

4.1.2. Materials and procedure

Name stimuli consisted of mostly the same names used in Experiments 1 and 2. However, the names with both round- and sharp-sounding phonemes were removed. These names were replaced, and four additional French and English names were added, in the same manner as previous experiments. These additional names were added in order to allow a fully crossed three-factor design (i.e., name gender, name type and font) with several observations per condition. See Table A.3 for a full list of French name stimuli, and Table A.4 for a full list of English name stimuli. We ensured that French round- and sharp-sounding names, and female and male names, did not differ in terms of their frequency in the Quebec baby name norms or their subjective familiarity to Moncton raters. We also ensured that English names did not similarly differ in terms of their frequency in the Alberta baby name norms or their subjective familiarity to Calgary raters (see Table 5).

Finally we examined if it was indeed the case that English names were more familiar to the Calgary participants than Moncton participants, and vice versa for the French names. An ANOVA examining subjective familiarity ratings, using city of rating (Calgary vs. Moncton) and name language (English vs. French) as factors, revealed a significant interaction $F(1, 46) = 14.30$, $p < 0.001$. Follow up tests showed that English names were significantly more familiar to raters in Calgary ($M = 3.18$, $SD = 1.49$) than to raters in Moncton ($M = 2.50$, $SD =$

Table 5
Québec and Alberta baby name frequencies per million people and mean subjective familiarity ratings for name stimuli used in Experiment 3.

	Name type			Name gender		
	Round	Sharp	*p*	Female	Male	*p*
Québec baby name freq. per million for French names	3.65 (2.19)	2.37 (2.85)	0.23	2.64 (2.97)	3.38 (2.16)	0.49
Alberta baby name freq. per million for French names	1.52 (2.14)	1.29 (2.18)	0.80	1.16 (1.75)	1.64 (2.49)	0.59
Mean Moncton familiarity rating of French names	4.86 (1.05)	4.76 (1.52)	0.85	4.51 (1.29)	5.11 (1.25)	0.26
Mean Calgary familiarity rating of French Names	4.29 (1.25)	4.36 (1.37)	0.89	4.37 (1.29)	4.29 (1.33)	0.88
Québec baby name freq. per million for English names	0.94 (0.87)	0.69 (1.60)	0.65	1.08 (1.64)	0.50 (0.70)	0.29
Alberta baby name freq. per million for English names	3.31 (4.03)	3.41 (4.94)	0.96	2.97 (3.94)	3.74 (4.98)	0.68
Mean Moncton familiarity rating of English names	2.82 (1.27)	2.19 (1.51)	0.28	3.06 (1.56)	1.94 (1.00)	0.05
Mean Calgary familiarity rating of English names	3.40 (1.40)	2.97 (1.61)	0.49	3.51 (1.69)	2.86 (1.25)	0.30

Note. Québec baby name frequency for English names does not include Leo.

Fig. 4. Examples of the Trench (top) and Geo (bottom) fonts. Trench was considered visually-round; Geo was considered visually-sharp.

1.40), $t(23) = 3.52$, $p = 0.002$; and that French names tended to be more familiar to raters in Moncton ($M = 4.81$, $SD = 1.28$) than to raters in Calgary ($M = 4.33$, $SD = 1.28$), but this difference was not significant, $t(23) = 2.02$, $p = 0.055$.

Names were presented visually in one of two fonts: Trench (available at https://creativemarket.com/NimaVisual/16159-Trench) or Geo (available at http://www.fontsquirrel.com/fonts/Geo). Trench was chosen because it contains no sharp corners, and all vertices appear as curves; thus Trench was considered a visually-round font. Geo was chosen because it contains no curves, and all vertices appear as right angles; thus Geo was considered a visually-sharp font. See Fig. 4 for a full inventory of these fonts. One half of each name type (e.g., one half of round-sounding, female French names) was presented in either font using all capital letters. Thus, font was manipulated within subjects but, across participants, each name was presented in both fonts.

Shape stimuli were identical to those used in previous experiments except that four additional silhouette pairs were added. These were created in the same manner as in Experiment 1. The procedure was identical to that described for Experiments 1 and 2.

4.2. Results

We examined the effects of name gender (male vs. female) and name type (sharp-sounding vs. round-sounding) on shape selection with a mixed effects logistic regression in which the dependent variable was the likelihood of selecting the round silhouette. Name gender and name type were dummy coded such that male names and sharp-sounding names were treated as reference categories.

Results indicated that participants were 2.21 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 8.18$, $p < 0.001$) and 1.92 times more likely when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 6.75$, $p < 0.001$), see Fig. 3d and e. For a summary of the model, see Table 6. This model was compared to one including a name gender x name type interaction, however including this as a predictor did not significantly improve model fit, $\chi^2(1) = 1.74$, $p = 0.19$.

A supplementary analysis examined if name frequency affected the likelihood of making a congruent pairing. We examined the effect of name frequency per million people (according to the baby name database associated to each language, calculated using the respective province's population) with a mixed effects logistic regression in which the likelihood of making a congruent pairing was the dependent variable. Name frequency was mean centred prior to conducting the analysis. We compared a model including only random subject and item intercepts to one also including frequency. Including frequency as a predictor did not significantly improve model fit, $\chi^2(1) = 0.00$, $p = 0.99$.

We next examined the effect of font (visually-round vs. visually-sharp) on shape selection. Font was dummy coded such that names presented in a visually-sharp font were treated as a reference category. We first examined the three-way interaction between font, name gender and name type. However, including this as a predictor did not significantly improve model fit, $\chi^2(1) = 0.25$, $p = 0.62$. We next investigated the relevant two-way interactions and found that adding an interaction between name gender and name font did not significantly improve model fit, $\chi^2(1) = 0.42$, $p = 0.52$; nor did adding an interaction between name type and name font, $\chi^2(1) = 1.38$, $p = 0.24$. Finally, we found that simply adding name font to a model only including random subject and item intercepts did not significantly improve model fit, $\chi^2(1) = 0.27$, $p = 0.61$.

We also conducted an analysis to investigate if the effects observed varied across languages. Results showed that including the three-way interaction between name gender, name type and name language did not significantly improve model fit, $\chi^2(1) = 2.39$, $p = 0.12$. We next investigated the relevant two-way interactions and found that including an interaction between name language and name gender did not significantly improve model fit, $\chi^2(1) = 0.27$, $p = 0.60$; nor did including an interaction between name type and name language, $\chi^2(1) = 1.56$, $p = 0.21$. Lastly, we investigated if name language affected the likelihood of making a congruent pairing. We compared a model only including random subject and item intercepts to one also including name language. Including name language as a predictor did not significantly improve model fit, $\chi^2(1) = 0.39$, $p = 0.53$.

Finally, we investigated if the observed effects might differ based on location. To that end we first examined the four-way interaction between name gender, name type, name language and location, however a model including this term failed to converge. We next investigated the

Table 6
Summary of logistic regression analysis in Experiment 3.

Fixed Effect	Coefficient	*SE*	Wald *Z*	*p*
Intercept	−0.33	0.10	−3.36	<0.001***
Name Gender	0.79	0.10	8.18	<0.001***
Name Type	0.65	0.10	6.75	<0.001***
Random effect				s^2
Subject intercept				0.18
Item intercept				0.04

$N = 2880$; log-likelihood = −1848.32; AIC = 3706.65.
*** $p < 0.001$.

Table 7
Québec and Alberta baby name frequencies per million people (averaged across all homophonic spellings of the name) and mean subjective familiarity ratings for name stimuli used in Experiment 4.

	Name type			Name gender		
	Round	Sharp	*p*	Female	Male	*p*
Québec baby name freq. per million for French names	4.98 (3.23)	4.38 (4.86)	0.75	4.07 (4.24)	5.29 (3.94)	0.52
Alberta baby name freq. per million for French names	2.87 (7.69)	1.97 (2.89)	0.73	3.72 (7.68)	1.12 (2.26)	0.32
Mean Moncton familiarity rating of French names	4.45 (1.19)	4.65 (1.56)	0.76	4.33 (1.42)	4.77 (1.31)	0.48
Mean Calgary familiarity rating of French names	3.77 (1.21)	4.40 (1.51)	0.31	4.33 (1.56)	3.84 (1.19)	0.44
Québec baby name freq. per million for English names	1.04 (0.93)	0.87 (1.74)	0.80	1.42 (1.72)	0.42 (0.58)	0.11
Alberta baby name freq. per million for English names	3.64 (4.62)	4.14 (5.74)	0.83	3.42 (4.37)	4.37 (5.91)	0.69
Mean Moncton familiarity rating of English names	2.82 (1.34)	2.18 (1.64)	0.35	3.15 (1.64)	1.85 (1.05)	0.05
Mean Calgary familiarity rating of English names	3.35 (1.54)	2.82 (1.65)	0.47	3.55 (1.83)	2.62 (1.19)	0.19

Note. Québec baby name frequency for English names does not include Leo.

relevant three-way interactions. We found that adding an interaction between name gender, name type, and location did not significantly improve model fit, $\chi^2(1) = 0.31$, $p = 0.58$; nor did adding an interaction between name gender, name language, and location, $\chi^2(1) = 0.02$, $p = 0.88$; nor did adding an interaction between name type, name language, and location, $\chi^2(1) = 1.12$, $p = 0.29$. Following this, we investigated the relevant two-way interactions. We found that adding an interaction between name gender and location did not significantly improve model fit, $\chi^2(1) = 1.81$, $p = 0.18$; nor did adding an interaction between name type and location, $\chi^2(1) = 0.92$, $p = 0.34$. Lastly we investigated if location affected the likelihood of making a congruent pairing. We compared a model only including random subject and item intercepts to one also including location. Including location as a predictor did not significantly improve model fit, $\chi^2(1) = 0.36$, $p = 0.55$.

4.3. Discussion

As in previous experiments, participants were more likely to pair round-sounding (or sharp-sounding) names, and female (or male) names with round (or sharp) silhouettes. These results once again demonstrate that the Bob/Kirk effect extends to names in both languages and populations. In addition, there was no evidence that the effect was moderated by name language or location, or their interaction. This suggests that a person's familiarity with a name does not modulate the Bob/Kirk effect.

We observed no evidence that font played a role in silhouette selection: the pairing between round-sounding (or sharp-sounding) names and round (or sharp) silhouettes was not affected by the visual roundness or sharpness of the names themselves. Moreover, there was no evidence that participants were more likely to pair names written in a visually-round (or visually-sharp) font with round (or sharp) silhouettes. This provides compelling evidence that the effect cannot solely be based in orthography. Instead, the phonology that participants generate for existing labels may be influential for sound symbolic effects.

5. Experiment 4

In Experiment 4 we further examined the relative roles of orthography and phonology by presenting names auditorily. This experiment examines the Bob/Kirk effect in another modality, and allowed us to vary the accent with which names were pronounced. As such, auditory presentation should highlight the differences in language between French and English names, perhaps providing a stronger test for cross-linguistic differences.

5.1. Method

5.1.1. Participants

Participants were 30 undergraduate students (19 female; *M* Age = 19.87, *SD* = 2.33) at the Université de Moncton reporting French fluency, and 30 undergraduate students (22 female; *M* Age = 19.33, *SD* = 1.63) at the University of Calgary reporting English fluency. All participants received course credit and reported normal or corrected to normal vision. Participants were asked to rate their fluency in English (Moncton participants) or French (Calgary participants) from 1 (cannot understand or speak English/French at all) to 5 (can easily carry on a conversation in English/French). Mean rating of English fluency among Moncton participants was 3.93 (*SD* = 0.64); mean rating of French fluency among Calgary participants was 1.87 (*SD* = 1.07).

5.1.2. Materials and procedure

Name stimuli consisted of audio files of 20 of the French names and 20 of the English names previously used in Experiment 3. See Table A.5 for a full list of French name stimuli, and Table A.6 for a full list of English name stimuli. We ensured that French round- and sharp-sounding names, and female and male names, did not differ in terms of their frequency in the Quebec baby name norms or their subjective familiarity to Moncton raters. We also ensured that English names did not similarly differ in terms of their frequency in the Alberta baby name norms or their subjective familiarity to Calgary raters (see Table 7). Because presentation was auditory, frequencies were computed by summing frequencies of all possible homophonic spellings of a name.

Finally we examined if English names were more familiar to the Calgary participants than the Moncton participants, and vice versa for the French names. An ANOVA examining familiarity ratings, using city of rating (Calgary vs. Moncton) and name language (English vs. French) as factors, revealed a significant interaction $F(1, 38) = 9.69$, $p = 0.004$. Follow up tests revealed that English names were significantly more familiar to raters in Calgary ($M = 3.09$, $SD = 1.58$) than to raters in Moncton ($M = 2.50$, $SD = 1.50$), $t(19) = 2.67$, $p = 0.015$; numerically, French names were more familiar to raters in Moncton ($M = 4.55$, $SD = 1.35$) than to raters in Calgary ($M = 4.08$, $SD = 1.37$), but this difference was not significant, $t(19) = 1.82$, $p = 0.09$.

Audio files were generated using Google translate's text-to-speech engine. We used the pronunciation in the target language: English pronunciation for English names and French pronunciation for French names. It was necessary to change the spelling of a few names in order to achieve the proper pronunciation. Audio recordings were created with Sound Tap Streaming Audio Recorder version 2.31, and sound files were edited with WavePad Sound Editor version 5.96. To test the quality of the audio files, we ran a pilot study with five English monolingual participants and seven French-English bilingual participants. These participants listened to the audio files in a random order, blocked by name language. After the presentation of each name, participants were asked to record the name they heard. Results revealed almost perfect performance, with the exception of two names that were then corrected.

Shape stimuli were the same as those used in previous experiments, except that each silhouette pair was presented twice, with the order of each pair (i.e., whether the round or sharp silhouette was on the left) counterbalanced. The procedure was the same as in previous experiments, except that names were presented auditorily instead of visually. On each trial, participants heard an audio recording of a name presented over headphones; audio files were presented as shape stimuli appeared. The language of names presented was blocked, with the block order counterbalanced across participants.

5.2. Results

We examined the effects of name gender (male vs. female) and name type (sharp-sounding vs. round-sounding) on shape selection with a mixed effects logistic regression in which the dependent variable was the likelihood of selecting the round silhouette. Name gender and name type were dummy coded such that male names and sharp-sounding names were treated as reference categories.

Results indicated that participants were 2.93 times more likely to select the round silhouette when presented with a female name than a

Table 8
Summary of logistic regression analysis in Experiment 4.

Fixed Effect	Coefficient	*SE*	Wald *Z*	*p*
Intercept	−0.54	0.12	−4.59	<0.001***
Name Gender	1.07	0.12	8.67	<0.001***
Name Type	0.61	0.12	4.94	<0.001***
Random effect				s^2
Subject intercept				0.16
Item intercept				0.07

$N = 2400$; log-likelihood = −1530.68; AIC = 3071.35.
*** $p < 0.001$.

male name (Wald $Z = 8.67$, $p < 0.001$) and 1.84 times more likely when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 4.94$, $p < 0.001$), see Fig. 3f. For a summary of the model, see Table 8. This model was compared to one including an interaction between name gender and name type. Including this interaction as a predictor significantly improved model fit, $\chi^2(1) = 10.16$, $p = 0.001$. Follow up tests indicated that on trials with female names, participants were 2.87 times more likely to select the round silhouette when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 6.41$, $p < 0.001$); on trials with male names, participants were not significantly more likely to select the round silhouette when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 1.65$, $p = 0.10$). In addition, follow up tests indicated that on trials with round-sounding names, participants were 4.28 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 10.27$, $p < 0.001$); on trials with sharp-sounding names, participants were 2.07 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 4.26$, $p < 0.001$).

A supplementary analysis examined if name frequency per million people (according to the baby name database associated to each language, calculated using the respective province's population) affected the likelihood of making a congruent pairing. We examined the effect of name frequency with a mixed effects logistic regression in which the likelihood of making a congruent pairing was the dependent variable. Name frequency was mean centred prior to conducting the analysis. We compared a model including only random subject and item intercepts to one also including frequency. Including frequency as a predictor did not significantly improve model fit, $\chi^2(1) = 0.58$, $p = 0.45$.

Next, we conducted a supplementary analysis to investigate if the effects observed varied across name languages. We found that including the three-way interaction between name gender, name type and name language did not significantly improve model fit, $\chi^2(1) = 0.06$, $p = 0.82$. Likewise an analysis of the relevant two-way interactions found that including the two-way interaction between name gender and name language did not significantly improve model fit, $\chi^2(1) = 0.01$, $p = 0.91$; nor did including the two way interaction between name type and name language, $\chi^2(1) = 0.09$, $p = 0.77$. We then investigated if name language affected the likelihood of making a congruent pairing. We compared a model only including random subject and item intercepts to one also including name language. Including name language as a predictor did not significantly improve model fit, $\chi^2(1) = 0.03$, $p = 0.87$.

Finally, we investigated if the observed effects differed based on location. To that end we first examined the four-way interaction between name gender, name type, name language, and location, however a model including this term failed to converge. We next investigated the relevant three-way interactions. We found that adding an interaction between name gender, name type, and location did not significantly improve model fit, $\chi^2(1) = 1.40$, $p = 0.24$; nor did adding an interaction between name gender, name language, and location, $\chi^2(1) = 0.88$, $p = 0.35$; nor did adding an interaction between name type, name language, and location, $\chi^2(1) = 0.41$, $p = 0.52$. Following this, we investigated the relevant two-way interactions**.** We found that adding an interaction between name type and location did not significantly improve model fit, $\chi^2(1) = 0.04$, $p = 0.84$; however, adding an interaction between name gender and location did, $\chi^2(1) = 11.60$, $p < 0.001$. In following up this interaction it was discovered that participants in Moncton were 3.94 times more likely to select the round silhouette when presented with a female name than a male name (Wald $Z = 7.44$, $p < 0.001$); participants in Calgary were 2.19 times more likely to select the round silhouette when presented with a round-sounding name than a sharp-sounding name (Wald $Z = 4.22$, $p < 0.001$). Lastly we investigated if location affected the likelihood of making a congruent pairing. We compared a model only including random subject and item intercepts to one also including location. Including location as a predictor did not significantly improve model fit, $\chi^2(1) = 0.04$, $p = 0.85$.

5.3. Discussion

In Experiment 4, we examined the Bob/Kirk effect under auditory presentation and the results were much the same as in the previous experiments using visual presentation. That is, participants were more likely to pair round-sounding (or sharp-sounding) names with round (or sharp) visual silhouettes. This provides further evidence that the effect is not solely based on orthography. The results could, of course, be consistent with orthography playing some role, as studies have shown that some orthographic information is accessed for words in auditory presentation (e.g., Seidenberg & Tanenhaus, 1979) and the same was likely true here. Nevertheless, the log odds of selecting a round silhouette when presented with a round- as opposed to a sharp-sounding name (i.e., how many times more likely a person was to select the round silhouette when presented with a round- vs. sharp-sounding name) in this study using auditory presentation (1.84) were comparable to those found in each of our preceding experiments using visual presentation (1.92, 1.62 and 1.92).

In a departure from the results of the previous experiments, the results of Experiment 4 showed some evidence that the Bob/Kirk effect was moderated by name gender. The notion that sound symbolic effects might in some cases be stronger for female names is consistent with an analysis of the phonemes used in typical male and female names, reported in Sidhu and Pexman (2015). That is, whereas typical female names included more round-sounding than sharp-sounding consonants, typical male names showed no significant difference in the proportions of round-sounding and sharp-sounding consonants. Although it is not clear why this is the case, the auditory presentation used in the present study seems to have enhanced the sound symbolic associations for female names and attenuated the associations for male names.

Aside from a stronger effect of name gender in French-English bilingual participants there was no evidence that results varied with respect to location or name language, and no interaction between these two factors. Thus, as in Experiment 3, there was no evidence that the Bob/Kirk effect was stronger for names in a participant's first language than for names in a different language. Notably, this was the case even when names were spoken in the corresponding English or French accent.

6. General discussion

The idea that the pairing between words and meaning is arbitrary in language has long been considered one of its defining features (Hockett, 1963; Saussure, 1916). This suggests that there is no a priori reason why any particular set of phonemes should be used to convey any particular meaning. However, studies on sound symbolism have called this categorical claim into question, by providing evidence that certain phonemes seem inherently associated with certain kinds of meanings (e.g., Köhler, 1929; Sapir, 1929). For instance, the Maluma/Takete effect has been taken as evidence that certain phonemes are associated with certain kinds of shapes (e.g., Ramachandran & Hubbard, 2001).

Thus far, however, there has been little evidence that the kind of sound symbolism involved in the Maluma/Takete effect will extend to real words (Sučević et al., 2013; Westbury, 2005; though for neuroimaging evidence see Sučević et al., 2015). One proposed reason for this is that words with learned meanings may be processed in a way that minimizes any effects of sound symbolism (Westbury, 2005). A recent study by Sidhu and Pexman (2015) did, however, find evidence that the Maluma/Takete effect influences associations to real first names. Participants were more likely to associate round-sounding names like *Bob* with round silhouettes, and sharp-sounding names like *Kirk* with sharp silhouettes, which we referred to as the Bob/Kirk effect.

In the present research we further explored sound symbolism in the context of existing labels, examining its extension to French speakers and French names. In Experiment 1 we replicated the findings of Sidhu and Pexman (2015) in a French-English bilingual population: participants were more likely to pair round-sounding (or sharp-sounding) English names with round (or sharp) silhouettes. In Experiment 2 we observed the same pattern when using French names. In Experiments 3 and 4 we examined both English and French names, in both English-speaking and French-English bilingual populations, and once again found the same pattern of sound symbolic effects. These results suggest that the findings of Sidhu and Pexman (2015) are not restricted to English names and an English-speaking population. This also suggests that they are not due to prominent examples of sound symbolically consistent words in the lexicon (e.g., a round-sounding word like *moon* that has a round referent; for a review of this critique, see Maurer et al., 2006) or salient examples of round Bobs and angular Kirks in the population studied. A potential avenue for future research would be to design a paradigm that could more precisely distinguish the effect of existing associations with the names from the effect of their phonemes. One possibility could be to examine existing names, as well as nonwords created by rearranging the phonemes in those names (e.g., *Lola* and *Lalo*). Because the phonemic content of the two groups of stimuli would be identical, any differences could be attributed to existing associations with the names.

Our findings, however, suggest that the influence of existing associations with names is not strong. That is, the Bob/Kirk effect was not modulated by familiarity of the names—neither in terms of a name's frequency or familiarity, nor its match with the population studied (i.e., French names examined in a French vs. English population). This suggests that the relative richness of existing associations a person has with a name does not impact the Bob/Kirk effect. Recall that one proposed reason for the scarcity of shape-sound symbolism effects in existing words was that real words (with semantics) might be processed differently than nonwords (Westbury, 2005). With this in mind, we may have expected more familiar names—ostensibly with a greater amount of associated content—to show a weaker effect. The results, however, provide no evidence of this.

In Experiments 3 and 4 we tested the mechanism at work in the Bob/Kirk effect—in particular, the roles of phonology and orthography. In the literature, there is evidence for (e.g., Bremner et al., 2013; Ozturk et al., 2013) and against (e.g., Fort et al., 2013; Rogers & Ross, 1975) the notion that the Maluma/Takete effect is based primarily on nonword phonology; in addition, there has been some recent support for a strong role for orthography in the Maluma/Takete effect (Cuskley et al., 2015). In the present Experiment 3 we conducted a direct test of orthography by comparing a visually-round and a visually-sharp font. By varying font we were able to examine the role of orthography while using the same phonemes that have been associated with roundness or sharpness in past studies. Results showed that font did not interact with phonemic roundness: round-sounding (or sharp-sounding) names were more likely to be paired with round (or sharp) silhouettes regardless of the font in which they were presented. In fact, there was no evidence that participants were more likely to associate names presented in the visually-round (or visually-sharp) font with round (or sharp) silhouettes. Finally, in Experiment 4 we presented names auditorily, thus minimizing effects of orthography, and still found the Bob/Kirk effect. Thus, with regard to first names, it seems that the inherent qualities of the phonemes themselves—namely their phonology and/or articulation—are the main contributors to the Bob/Kirk effect. Notably, these are features that we would expect to transcend culture and language and, indeed, sound symbolic effects seem to transcend writing systems.

In general, these results provide evidence against an explanation of the Bob/Kirk effect based primarily in orthography. Of course, we cannot rule out the possible influence of abstract grapheme knowledge.[1] However, we can conclude that the apparent perceptual roundness/sharpness of letters does not play a primary role in the association between certain phonemes and shapes. Instead, these results are consistent with an interpretation of the effect being due to a crossmodal association between the phonology and/or articulation of the phonemes, and the shape stimuli. This association may be due to a synesthetic congruence, possibly due to the proximity of areas in the brain that process these sensations (Ramachandran & Hubbard, 2001; Ramachandran & Hubbard, 2005). Another possibility is that it may arise due to a co-occurrence of these stimuli in the environment (Spence, 2011).

It is somewhat surprising that font did not play a role given previous studies in which it moderated the sound symbolic effects of invented product names (e.g., Doyle & Bottomley, 2011). It may be that people are more accustomed to taking the visual appearance of letters into consideration when dealing with product names (i.e., in logos) as opposed to first names. In addition, Doyle and Bottomley (2011) explained the effect for product names as being based on a match between the *connotations* of fonts and targets, as opposed to the visual similarity of fonts and targets. This may suggest certain boundary conditions on the effects of font.

The results of the present experiments lead to quite different conclusions than those described by Cuskley et al. (2015). It is important to remember that the two studies employed different kinds of stimuli (real first names vs. nonwords) and task decisions (binary forced choice vs. likert scale responses). In addition, the roundness and sharpness of nonword stimuli used by Cuskley et al. were classified solely by their voicing. In the present experiments, phonemes were not chosen based on a particular articulatory dimension, but instead based on their association with roundness and sharpness in previous studies. Thus, perhaps orthography is a stronger predictor of shape association than voicing alone, but several phonological/articulatory features in concert are more strongly associated with shape than orthography (see D'Onofrio, 2013, for evidence that a combination of certain phonological features leads to a stronger Maluma/Takete effect). Of course, unlike in Cuskley et al., the design of the present study did not allow us to rule out the influence of abstract grapheme knowledge on participants' decisions.

As observed by Sidhu and Pexman (2015), participants in the present study were more likely to associate female (or male) names with round (or sharp) silhouettes. As to the origin of this association we can only speculate, and note that femininity has long been associated with curves (Rice, 1981). Conversely, masculinity is often associated with certain sharp features—indeed males possessing broad shoulders (Keating, 1985) and square jaws (Dixson, Halliwell, East, Wignarajah, & Anderson, 2003) are rated as more attractive. Certainly, round and sharp shapes have also been shown to be associated with certain personality traits (Lyman, 1979), and these may also moderate the relationship between gender and shape. Given the imbalance between numbers of male and female participants in the experiments reported here, we did not test for effects of participant gender. However, Sidhu and Pexman (2015) examined this in their Experiment 1a and found no main effect of participant gender, nor any interaction between participant gender and name gender or type. That experiment was well powered ($N = 53$), and included a relatively equal number of each gender (30 females).

In the present study we contrasted English and French speakers, and the latter were French-English bilinguals. It will be important for future studies to examine these effects in groups who differ dramatically in terms of language experience. We should also note that although our comparison between English speakers and French-English bilinguals involved a contrast of language, it did not involve a strong contrast of

[1] To examine letter shape associations, we conducted a survey in which we verbally asked 20 participants (10 each from Calgary and Moncton) to rate the shape of uppercase versions of each of the letters employed here from 1 (very sharp) to 7 (very round). As would be expected, even without seeing the letters, results were very much consistent with participants having access to some abstract grapheme knowledge. For instance, the letter *K* was rated as extremely sharp ($M = 1.55$, $SD = 0.61$) while the letter *O* was rated as extremely round ($M = 7.00$, $SD = 0.00$). See Table B.1 for complete results.

culture. Our participant groups were drawn from the same country; in contrast to previous studies (e.g., Bremner et al., 2013; Davis, 1961), this allowed us to examine effects of language while keeping culture relatively constant. Nevertheless, future tests of the Bob/Kirk effect should examine other cultures, perhaps those in which first names hold a different status than within Canadian culture. For instance, within Judaism, first names are meant to be a description of a person's traits and personality, and may even be seen as portents of the future (Krohn, 2007). It is possible that these cultural factors moderate the impact of sound symbolic features of a person's name. It is also not especially surprising that participants in Calgary and Moncton had similar associations with respect to gender. An interesting topic for future research could be to examine a culture with different concepts of femaleness and maleness, and to test the association with roundness and sharpness in that context.

Taken together, these results provide evidence that the sound symbolic properties of phonemes used in existing labels can have an impact on the information with which they are associated. This form of sound symbolism generalizes across names from at least two languages and populations and does not seem to be modulated by name frequency. In addition, the Bob/Kirk effect, or the Benoit/Éric effect, does not appear to be driven by the names' orthography. Instead, the effect seems to be driven by fundamental features of the phonemes (i.e., their phonology and/or articulation), features that transcend language, region, and any particular orthographic representation. Thus these results are consistent with the proposal of Bremner et al. (2013), that the Maluma/Takete effect arises from a universal association, or at least one that is easily available based on salient associations in the environment. In a broader sense, these results demonstrate that while the majority of existing language is arbitrary, there are associations between certain phonemes and certain meanings. These associations can have an effect on the ways that we interpret existing labels.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.actpsy.2016.05.011.

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