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Developing Associations to the Sounds of a Name

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ABSTRACT

Sound symbolism refers to associations between language sounds and certain perceptual or semantic properties. One well-studied example is the maluma/takete effect, in which individuals tend to associate round-sounding nonwords like maluma with round shapes, and spiky-sounding nonwords like takete with spiky shapes. This phenomenon suggests that certain sounds are perceived as better suited to particular visual shapes, and it provides a means by which language can be non-arbitrary. Research has demonstrated that sound symbolism further extends from nonwords to real first names, a phenomenon known as name sound symbolism. In addition to phonological cues, research on name sound symbolism reveals an association between a name's perceived gender and shape: femaleness is associated with roundness, whereas maleness is associated with spikiness. However, previous studies have focused on adults, leaving open the question of whether children also show these associations. The present study examined the emergence of name sound symbolism in children, considering individual differences such as age and language ability. Results indicated that adults exhibit stronger sensitivity to both name sound symbolism and gender-shape associations than children. Although the gender-shape association is present in 5- to 7-year-olds, name sound symbolism may emerge at a later age. Our results point to the possibility that the presence of semantic meanings or sociolinguistic information like gender may compete with phonological cues when processing real words, thus attenuating the sound symbolic effect. These findings have important implications on how sound symbolism operates in nonwords versus in real words.

1 | Introduction

Research on sound symbolism has demonstrated that people associate certain semantic and/or perceptual properties with different sounds of language (for reviews see Lockwood and Dingemanse 2015; Sidhu and Pexman 2018). The most notable example of this phenomenon is shape sound symbolism (i.e., the maluma/takete effect; Köhler 1929; also referred to as the boubu/kiki effect; Ramachandran and Hubbard 2001). This refers to the finding that when shown a round shape and a spiky shape, and asked which is the “maluma” and which is the “takete”, there is an overwhelming tendency to associate maluma with the round shape and takete with the spiky shape (e.g., Ćwiek

et al. 2022; Sidhu and Pexman 2017; Styles and Gawne 2017). More generally, sonorant consonants (e.g., /l, m, n/) and round vowels (e.g., /u, ou/) are associated with round shapes, while voiceless stop consonants (e.g., /p, t, k/) and unrounded front vowels (e.g., /i/) are associated with spiky shapes. The effect has been demonstrated across different cultures, languages, and writing systems (Ćwiek et al. 2022; Styles and Gawne 2017; also see these papers for notable exceptions). This finding demonstrates that the multimodal aspects of language can contribute to meaning.

There have been several explanations offered for sound symbolism and the maluma/takete effect (for a review see Sidhu and Pexman 2018). One explanation has included a resemblance

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Summary

- Although adults showed sensitivity to name sound symbolism, the effect is still developing in children and may emerge after 7 years of age.
- Gender-shape association exists for both adults and children, and the association is stronger in adults than in children.
- Adults showed stronger effects of both name sound symbolism and gender-shape association than children, indicating adults' ability to attend to both sources of information simultaneously.
- Sound symbolism is attenuated in real words due to additional cues like semantic meanings. This suggests non-phonological factors may override phonological information in real words.

between certain language sounds and the sounds made by round and spiky objects (Fort and Schwartz 2022).¹ Another is that language sounds and shapes might have affective qualities (in particular level of arousal) in common (Aryani et al. 2020). A final explanation is that these associations might arise, or be strengthened by, patterns in language (see Akita and Imai 2022; see Sidhu et al. 2021 for evidence of these patterns in English). Importantly, these explanations need not be mutually exclusive.

In the current research we examined the maluma/takete effect across two previously distinct areas of study: the development of sound symbolism, and the effects of sound symbolism in the context of first names. We next review each of these in turn.

1.1 | Development of Sound Symbolism

Several studies have examined the maluma/takete effect in infants, providing insight into the age at which the effect appears. Most of these studies have used a looking time paradigm in which infants are shown round and spiky shapes while hearing round or spiky nonwords. Using this approach, Pejovic and Molnar (2017) showed that at 12 months infants looked longer at a shape when it was accompanied by an incongruent word. Notably, this was not observed in a group of 4-month-olds. There is also converging neuroimaging evidence that infants are sensitive to the maluma/takete effect by 1 year. Using electroencephalogram (EEG) recording, Asano et al. (2015) demonstrated differences in brain activity when 11-month-olds processed sound symbolically congruent versus incongruent pairs of shapes and nonwords. Yang et al. (2019) also found differences in brain activity in response to congruent versus incongruent pairs in the same age group using near-infrared spectroscopy (NIRS). Note that this difference was only found in round, and not spiky, nonwords. These studies suggest that sensitivity to shape sound symbolism emerges by the end of the first year. Interestingly, in a meta-analysis of the literature Fort et al. (2018) found that the effect's developmental trajectory may also depend on the kind of shape, with round associations appearing earlier than spiky ones, and spiky associations developing as children age.

There is a complex and potentially bi-directional relationship between children's sensitivity to sound symbolism and their developing language abilities. Some have proposed that sound symbolism (and the perception of form-meaning resemblance in meaning more broadly, i.e., *iconicity*) may help children acquire language (Imai and Kita 2014; Nielsen and Dingemanse 2020; Perniss and Vigliocco 2014). Although some have made the broad claim that these links might help with language learning in general, the more common stance is that words which demonstrate form-meaning resemblance may be easier to acquire. Indeed, laboratory studies demonstrated that the acquisition of sound symbolic words was facilitated in 14-month-olds (Imai et al. 2015), and that 2- to 3-year-olds were better able to generalize the meanings of sound symbolic verbs.

There is related speculation that language experience could reinforce sensitivity to sound symbolism. For instance, Fort et al. (2018) suggested that sensitivity to sound symbolism, particularly for spiky words, could depend on experience with objects in the environment and/or with language. This would suggest that sensitivity to some sound-meaning links is present early on, but that at least some associations are strengthened through experience. Notably, research has shown that there are sound symbolic patterns in language (Sidhu et al. 2021). Exposure to these patterns could strengthen sensitivity to sound symbolism (Akita and Imai 2022; Imai and Kita 2014). It could also be that some aspects of language ability (e.g., phoneme perception) could enhance sensitivity to sound symbolism.

In order to investigate the proposed links between experience and sensitivity to sound symbolism, Sidhu et al. (2023) conducted a longitudinal study of infant sound symbolism, testing the same participants at 4, 8, and 12 months of age. This study also explored the developmental milestones that might lead to sound symbolism emerging at 1 year of age. To that end, Sidhu et al. measured individual differences in language ability (i.e., the MacArthur-Bates Communicative Developmental Inventories, which include receptive and productive vocabulary scores; *CDI*), and infants' abilities to traverse the environment (which served as a proxy for experience with objects in the environment). However, none of receptive vocabulary, productive vocabulary, nor movement measures predicted sensitivity to sound symbolism. Only babbling ability marginally predicted infants' emerging sensitivity to sound symbolism.

One complication in the work by Sidhu et al. (2023) was a potential floor effect in the *CDI* measures. At 12 months old, the average production score on the *CDI* was 1.34/89 while the average receptive score was 16.73/89. One possible avenue to test the influence of language ability is to study an older sample. The existing evidence suggests an increase in sensitivity to sound symbolism over time. By two and a half years of age children are sensitive to sound symbolism, as they perform above chance on a nonword-shape matching task (Maurer et al. 2006; Spector and Maurer 2009). Tzeng et al. (2017) tested 3-, 5-, and 7-year-old children on a matching task, and found that the tendency to make a congruent pairing increased with age. Early work by Irwin and Newland (1940) suggested that the effect of sound symbolism continued to increase until age 9, when it stabilized to adult levels.

In the present work we examined the development of sensitivity to sound symbolism in older children, and explored whether individual differences in language ability contributed to this development.

1.2 | Name Sound Symbolism

Although the majority of work on the maluma/takete effect had focused on invented meaningless nonwords, Sidhu and Pexman (2015; see also Sidhu and Pexman 2019 and Sidhu et al. 2016) extended the effect to real first names. They found that participants associated round-sounding names (e.g., Molly) with a round alien silhouette, and spiky-sounding names (e.g., Katie) with a jagged alien silhouette. This finding was important for theory development as it demonstrated that sound symbolism can have an effect in linguistic stimuli with which participants already have some familiarity. Other research has also shown that individuals pair round- and spiky-sounding names with round and angular faces (Barton and Halberstadt 2018). Beyond shape associations, round and spiky sounding names are associated with distinct personalities (i.e., Agreeableness and Emotionality on the one hand, Extraversion on the other; Sidhu et al. 2019).

Research on name sound symbolism exists within a broader context of associations deriving from the sounds in names. For example, there is a great deal of research demonstrating that male and female English names tend to contain different sounds. Barry and Harper (1995) found that American girl names were more likely to end in a schwa (/ə/; the final sound in “Kayla”) while boy names were more likely to end in a stop consonant (see also Pitcher et al. 2013; Sidhu and Pexman 2015; Slepian and Galinsky 2016). Importantly, individuals are sensitive to these patterns, and will use them to infer the gender of a toy associated with an invented name (Cassidy et al. 1999). They will even do so for names from a different language (Cai and Zhao 2019). Beyond conveying gender, the patterns in names have also been shown to affect perceptions of race (Bertrand and Mullainathan 2004; Obenauer 2023) and age (Young et al. 1993).

In the present study we examined the development of sensitivity to name sound symbolism. Importantly, sound symbolism in names is a more complex process than shape sound symbolism (nonwords and abstract shapes). Name sound symbolism requires the additional process of making an inference about a person based on the sounds in their name. As such, it involves reasoning about other people and their characteristics as separate from one's own. Infants recognize the sounds of their name in a stream of speech by 4 months of age, pick their own name out of a speech stream by 5 months of age (Mandel et al. 1995), and use their own names by 6 months as a cue to process objects presented visually (Parise et al. 2010) and to segment the following word in the speech stream (Bortfeld et al. 2005). By 2 years infants know that certain kinds of things can share a common name (i.e., “dolls”) while also having individual names (e.g., a doll named “Molly”; Katz et al. 1974). In addition, by 4 years of age, children can infer the gender of a name based on its stress pattern and final phoneme (Cassidy et al. 1999). This finding suggests that infants can infer qualities about a person based on the properties in their name. It remains an open question at what age this ability extends to sound symbolism in names.

1.3 | Gender and Shape

Work on name sound symbolism has also revealed an association between gender and shape. In particular, Sidhu and Pexman (2015; Sidhu et al. 2016) found that female names were associated more often with a round alien silhouette, while male names were associated with a spiky alien silhouette. Notably, this association was orthogonal to any effects of sound symbolism (i.e., the two properties in a name did not interact). This finding is consistent with other work exploring associations between gender and shape. For example, Blazhenkova and Kuman (2018) found that female and male genders were associated with round and spiky abstract shapes, respectively. Stroessner et al. (2020) also found evidence of this association with Likert scale ratings and in an Implicit Association Task.

There are several mechanisms proposed to explain crossmodal correspondences (Motoki et al. 2023; Spence 2011), and two are especially relevant here: statistical co-occurrence (i.e., perceptual features that tend to co-occur in the real world) and shared affective qualities. Stroessner et al. (2020) reviewed several ways in which shape might co-occur with gender in the real world and lead to gender-shape associations. The first is the typical physical features of men and women. For example, women tend to have rounder bodies than do men, who tend to have boxier forms. Men also tend to have more pronounced jaws and visible bone structure. Stroessner et al. (2020) also mention the kinds of toys that children of either gender are encouraged to play with (e.g., round dolls for girls; angular cars for boys) and the Western symbols used for each gender (e.g., circles for females; squares for males) as other possible origins of the association. Finally, it is also possible that gender and shape share affective qualities in common. For example, the association between curved shapes and femaleness may stem from the concept of friendliness, as this idea is linked to both curved shapes (Lyman 1979) and the female gender.

In the present work we further examined the developing association between gender and shape. Although we are unaware of any such research, there is a great deal of work exploring developing conceptions of gender. Infants distinguish female and male faces by 4 months of age (Quinn et al. 2002) and associate male and female faces with male and female voices by 6 months (Miller 1983). Children begin using gender label words such as “boy” and “girl” by 21 months (Zosuls et al. 2009) and are able to apply gender labels to more abstract social concepts by 24–28 months (Campbell et al. 2002; Martin and Ruble 2010). With an understanding of the concept of gender, children begin exhibiting adult-like cultural gender role stereotypes between 2 and 3 years (Kuhn et al. 1978; Signorella et al. 1993). They show more stereotypical beliefs with development, with a peak around 5–6 years of age (Miller et al. 2009; Ruble et al. 2007). Here we examined the development of crossmodal associations to children's concepts of gender.

1.4 | Present Study

We investigated the development of name sound symbolism, and gender-shape associations, in children, and explored the relationship of language skills to developing sensitivity to those

associations. We extended the methodology of Sidhu and Pexman (2015) to child participants, while also testing a comparison group of adults. We used a newly selected set of names, thus also testing whether adult name sound symbolism generalizes to a new set of stimuli (i.e., beyond those of Sidhu and Pexman 2015; Sidhu et al. 2016). We compared responses of adults and children, and we also tested children at three different ages (5, 6, and 7 years), to examine the trajectory of sensitivity across these ages. Previous work found increases in sensitivity to sound symbolism in this age range (Tzeng et al. 2017) and it is a period of significant language change (Lloyd et al. 1998; Szaflarski et al. 2006). At 5 years, children often fail to respond accurately to ambiguous messages or to provide sufficient information about a target object (Lloyd et al. 1998). By 7 years, however, they show an improved ability to recognize when a message is unclear and to request clarification. Between the ages of 5 and 7 years children also show substantial improvement in their lexical processing (Lund et al. 2019) and pragmatic language skills (Harris and Pexman 2003). Neuroimaging evidence further demonstrates increasing specialization of core left-hemisphere regions for language processing with age, combined with decreasing reliance on less specialized regions (Szaflarski et al. 2006). Since sound-symbolic mappings could stem from sensitivity to the communicative value of language forms, these concurrent pragmatic and neural developments may make children increasingly attuned to how non-arbitrary sound patterns can help disambiguate meaning.

We included two measures of language development. Children's receptive vocabulary was assessed using the Peabody Picture Vocabulary Test 4th Edition (PPVT-4; Dunn and Dunn 2007) and parents completed the Children's Communication Checklist Second Edition (CCC-2; Bishop 2013), which provides a broad measure of overall communication abilities, including both structural and pragmatic language use. We tested children between the ages of 5 and 7 years to avoid floor effects in these language measures. Focusing on this age group also allowed us to use explicit choice as a measure, rather than looking time, which arguably simplifies the inferences about sensitivity to sound symbolism.

We predicted that adults would demonstrate a larger sound symbolism effect than children (see Irwin and Newland 1940). As in previous work on nonword sound symbolism (e.g., Tzeng et al. 2017), we further predicted that older children would demonstrate a larger sound symbolism effect than younger children. If language development is critical to the development of sound symbolism, we also expected that children with more developed language skills would show a larger sound symbolism effect. Finally, if gender-shape associations develop over time, we also expected that adults and older children would demonstrate larger effects of gender-shape association than would younger children.

2 | Method

2.1 | Power Analysis

We began with a power analysis conducted in R (R Core Team 2024) using the “simr” package (Green and MacLeod 2016). Code for this is available on osf: <https://osf.io/bq2jt/>. In particular, we ran a simulation using data from a previous study involving the task that we planned to use here (i.e., selecting between a round

and spiky silhouette for a name; Experiments 1 and 2 in Sidhu and Pexman 2015) to generate estimates of effect size. This consisted of a logistic mixed effects regression predicting the probability of choosing the round silhouette for a name, with effects coded name gender (female vs. male) and name type (round vs. spiky) as fixed effects. This model also included random subject and item intercepts. This revealed a coefficient of $b = 1.15$ for name type and $b = 0.97$ for name gender. We computed a simulated power analysis ($N_{\text{Simulations}} = 1000$) based on the above model to estimate the power to detect the effect of name type in each age group. Based on a previous study comparing adults and infants (between 2 and 3 years old; Maurer et al. 2006), we assumed that the effect size of name type in children would be half of what we observed in adults (i.e., assumed a coefficient of $b = 0.58$ for name type). This power analyses suggested that with 30 participants in a given age group, we would have 93% power to detect an effect in that age group at $\alpha = 0.05$.² We aimed to recruit 30 participants of each age (i.e., 5-, 6-, and 7-year-olds). Due to convenience sampling this was surpassed in two out of three age groups, and not reached in one (i.e., only 25 6-year-olds were tested; resulting in 88% power). Note that this power analysis did not account for interactions which were included in later models. Also note that this power analysis was done for frequentist models, while subsequent analyses comprised Bayesian parameter estimation.

2.2 | Participants

Over the course of data collection, we were able to recruit 131 typically developing child participants aged 5–7 years from the participant database of the Child and Infant Learning and Development (Ch.I.L.D.) research group at the University of Calgary. Parents reported that each of these children had greater than 80% English language use when they were contacted about the study. Due to a programming error, the data of 20 participants were not saved. At the time of the experiment a further five child participants reported less than 80% English language use. They were included in the analyses as their exclusion did not alter the interpretation of results. We aimed to recruit an equal number of 5-year-olds, 6-year-olds, and 7-year-olds with approximately an equal distribution of boys and girls in each age group. During analysis, two participants were excluded: one due to missing data and another as they chose the target on the right side of the screen at a rate that was greater than three standard deviations from the mean (i.e., selected the target on the right side of the screen on 86% of trials). The final data set for analysis included 109 children (50 females; $M_{\text{age}} = 6.58$ years, $SD = 0.95$). For the purposes of an additional categorical analysis, we considered separate groups of 5-year-olds ($n = 43$; 17 females), 6-year-olds ($n = 25$; 12 females), and 7-year-olds ($n = 41$; 21 females).

We recruited 44 adult participants (39 females, $M_{\text{age}} = 20.25$ years, $SD = 4.16$) from the Research Participation System (RPS) of the Department of Psychology, University of Calgary. Adult participants were undergraduate students who reported English fluency.

2.3 | Materials

Study materials were modified from a previous study by Sidhu and Pexman (2015).

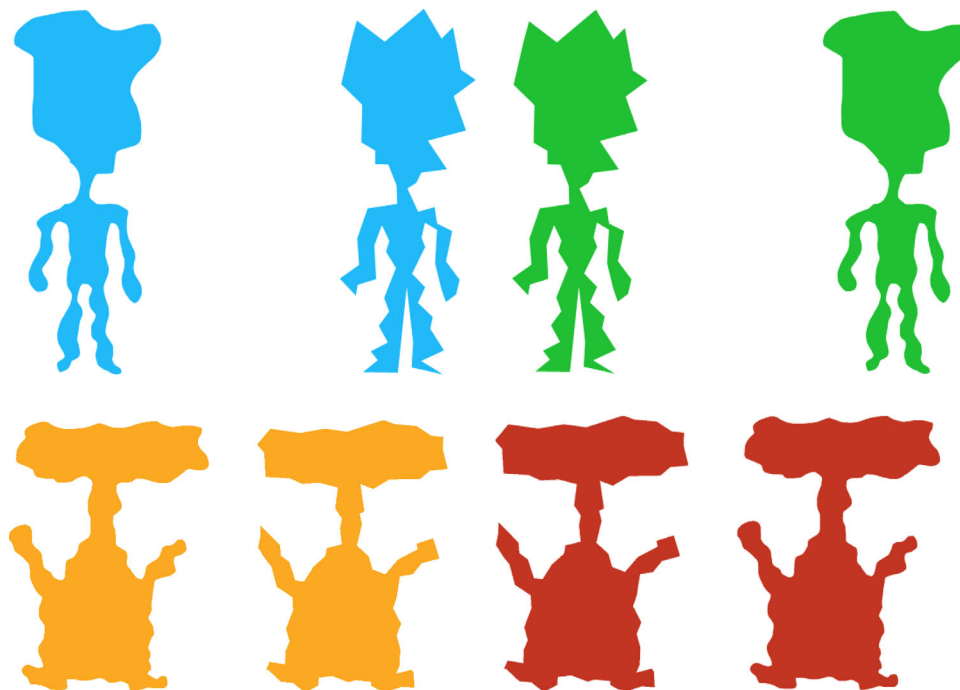


FIGURE 1 | Examples of alien-like silhouette pairs.

2.3.1 | Name Stimuli

We accessed registered baby first names and their frequency in Alberta from the Alberta Services Agency. In line with previous research (Sidhu et al. 2019) we considered sonorant consonants including /l/, /m/, and /n/ to be round-sounding, and voiceless stop consonants including /t/, /k/, and /p/ to be spiky-sounding. Although both consonants and vowels contribute to sound symbolic correspondence, research suggests that consonants play a stronger role in shape sound symbolism (Nielsen and Rendall 2011). To facilitate matching given the constraints of real names, vowels were not considered when categorizing name type. Based on these criteria, 36 round names and 36 spiky names (henceforth *name type*) were selected from the registered baby names, with equal numbers of male and female names in each name type. The 72 names were divided into two experimental lists, each containing 36 names, with an equal number of each name type and gender. Names in each of these eight groups (i.e., name type $\times$ gender $\times$ counterbalanced list) were matched on frequency, number of syllables and number of sound symbolic consonants using *t*-tests (all $p > 0.42$), and then the number of names in each group beginning with a relevant phoneme using logistic regression ($p = 0.33$). All name stimuli were spoken and recorded by a male Research Assistant who was blind to the experimental design, and these recordings served as stimuli in the experiment. Male and female name recordings did not differ in mean ($p = 0.09$) nor maximum pitch ($p = 0.17$). They also did not differ in mean ($p = 0.07$)³ nor maximum amplitude ($p = 0.19$).

2.3.2 | Shape Stimuli

The shape stimuli were 40 alien-like silhouette pairs from Sidhu and Pexman (2015). Each pair included one round alien and one spiky alien. Each pair was created from the same image source,

with the round shape generated using a wavy outline and the spiky shape generated using a jagged outline. Thus, the shapes in a pair differed only in their outline. The pairs of aliens were solid blue, green, red, or orange. There was a version of each that counterbalanced the order of presentation (i.e., whether the round silhouette was on the right or left). Examples of the stimuli are shown in Figure 1 below.

2.3.3 | Child Language Skills

The PPVT-4 was administered to child participants to measure their receptive English vocabulary. The PPVT-4 was administered after a short break following the alien sorting task described below. The CCC-2 was completed by each child's caregiver to measure their child's language skills in English while the child participant completed the alien sorting task.

2.4 | Procedure

This experiment was approved by the University of Calgary Conjoint Faculties Research Ethics Board (REB17-0415).

2.4.1 | Alien Sorting Task

Participants were presented with the alien sorting task on a computer to measure name sound symbolism. Adults were told that they were participating in an experiment designed for children. Following informed consent, the participant was seated in front of a computer in the testing room. Participants were told that some aliens had just arrived on Earth, and that these aliens needed to be assigned a name to help them adjust to the new environment. The experiment consisted of 40 trials, with four practice trials and

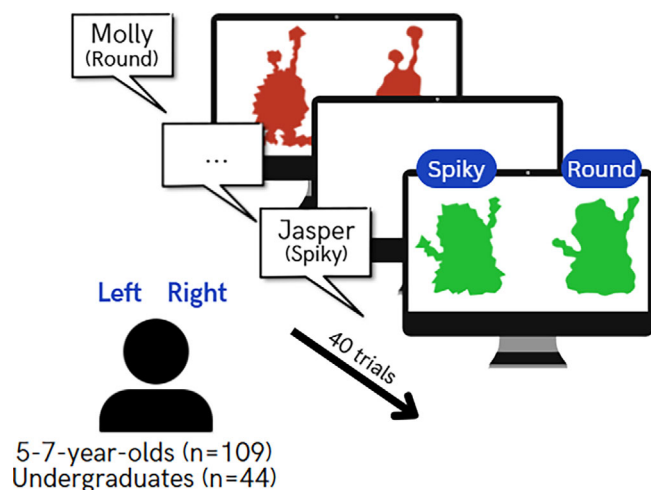


FIGURE 2 | Procedure of the alien sorting task.

36 experimental trials. In each trial, participants were presented with a name twice by audio recording and then were asked to repeat the name presented. If the participant was not able to repeat the name presented, the audio recording of the name was played again, and they were asked to repeat the name again. This process was repeated until the participant correctly repeated the name presented. Next, participants were presented with an alien silhouette pair, with one round and one spiky alien. Participants were asked to choose the silhouette that best matched the name by pointing at the alien (see Figure 2). The experimenter always responded positively no matter what choice the participant made.

3 | Results

3.1 | Analysis Plan

Analyses consisted of mixed effects logistic regression models, computed using Bayesian parameter estimation. Analyses were conducted in R (R Core Team 2024), using the package “brms” (Bürkner 2017). Analyses were run using four sampling chains, each with 4000 iterations; the first 2000 of these were treated as warmups, resulting in 8000 posterior samples. Models were fit with weakly informative priors: a normal distribution centered at 0 with a standard deviation of 0.50 for the intercept, and Cauchy distributions centered at 0 with a scale of two and a half for all fixed effects (see Gelman et al. 2008). All terms had an R-hat of 1.00, suggesting good convergence.

The dependent variable for all models was the probability of choosing the round silhouette. We began with an overall analysis that compared sensitivity to name sound symbolism and gender-shape associations between adults and children. The independent variables in this model were the age group (i.e., adults vs. children), name type (i.e., round vs. spiky), name gender (i.e., female vs. male), the interaction between age group and name type, and the interaction between age group and name gender. We then analyzed data for adults and children separately. In these two models, the independent variables were name type and name gender. Focusing on children, we next tested whether sensitivity to name sound symbolism and gender-shape association increased with age. The independent variables in this model were name

type, name gender, age (in months), the interaction between name type and age, and the interaction between name gender and age. Lastly, we examined whether individual differences in language skills (measured by the PPVT-4 and CCC-2) interacted with sensitivity to name sound symbolism, controlling for name gender. The independent variables in these two models were name type, name gender, PPVT-4 scores, and the interaction between name type and PPVT-4 scores.

Models included all possible random subject and item effects. In practice, this meant including a random subject intercept and slope for name type and name gender; a random name intercept; and a random image intercept and slope for name type, and name gender. We interpreted each fixed effect’s 95% credible interval (i.e., the range of values with a 95% probability of containing the true value of a given parameter). When a given parameter’s credible interval did not include zero, this was considered evidence for a statistically credible effect. Note that this terminology, as opposed to “statistically significant”, is more typical for Bayesian analyses (Matthews 2019).

3.2 | Comparison of Adults and Children

Our initial analysis included all participants. Our fixed effects of interest were name type (round vs. spiky), name gender (female vs. male), and group (adult vs. children), as well as interactions between name type and group, and name gender and group. Our fixed effects were all effects coded. The analysis revealed a main effect of name type such that participants were more likely to select the round silhouette as a match for round names than spiky names ($B = 0.53$, 95% CI [0.34, 0.71]); and a main effect of name gender such that participants were more likely to select the round silhouette as a match for female names than male names ($B = 0.51$, 95% CI [0.31, 0.72]). These were qualified by a statistically credible interaction between group and name type ($B = 0.74$, 95% CI [0.44, 1.06]), and between group and name gender ($B = 0.53$, 95% CI [0.19, 0.88]). The nature of these were that name type and name gender had larger effects in adult participants compared to children (see Figures 3 and 4). Statistics from the resulting model are shown in Table 1. Further, there was a statistically credible intercept, indicating that participants were overall more likely to select the round silhouette (Intercept = 0.37, 95% CI [0.23, 0.52]; i.e., a *round bias*). Note that there was not a statistically credible effect of group, indicating that this round bias did not vary by age ($B = -0.03$, 95% CI [-0.31, 0.25]).

Next, we explored the interaction between Age and Name Type as well as the interaction between Age and Name Gender by examining data for adult and child participants separately. In the analysis of the adult data, we included the fixed effects of name type and name gender. This revealed statistically credible main effects of both name type ($B = 0.90$, 95% CI [0.55, 1.27]) and name gender ($B = 0.79$, 95% CI [0.40, 1.20]), such that participants were more likely to select the round silhouette for round names and female names (see Figure 5). Statistics from the resulting model are shown in Table 2. The analysis of child data found no statistically credible effect of name type ($B = 0.16$, 95% CI [-0.02, 0.33]) but did find a statistically credible effect of name gender ($B = 0.25$, 95% CI [0.06, 0.45]) such that participants were more likely to select the round silhouette

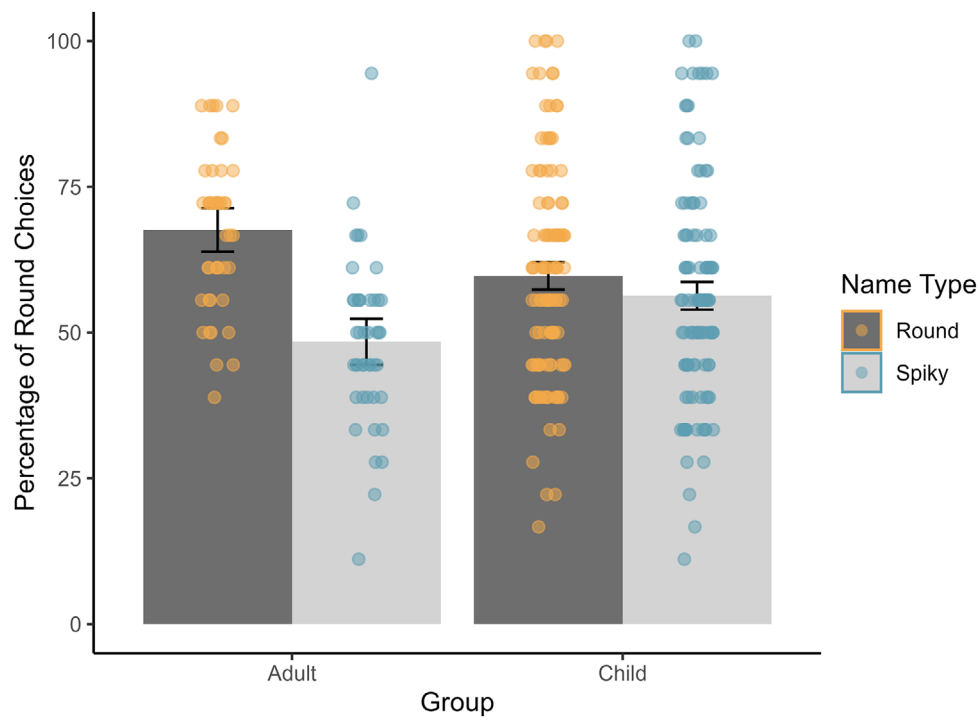


FIGURE 3 | Percentage of round choices by name type and participant group. Subject means are plotted. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

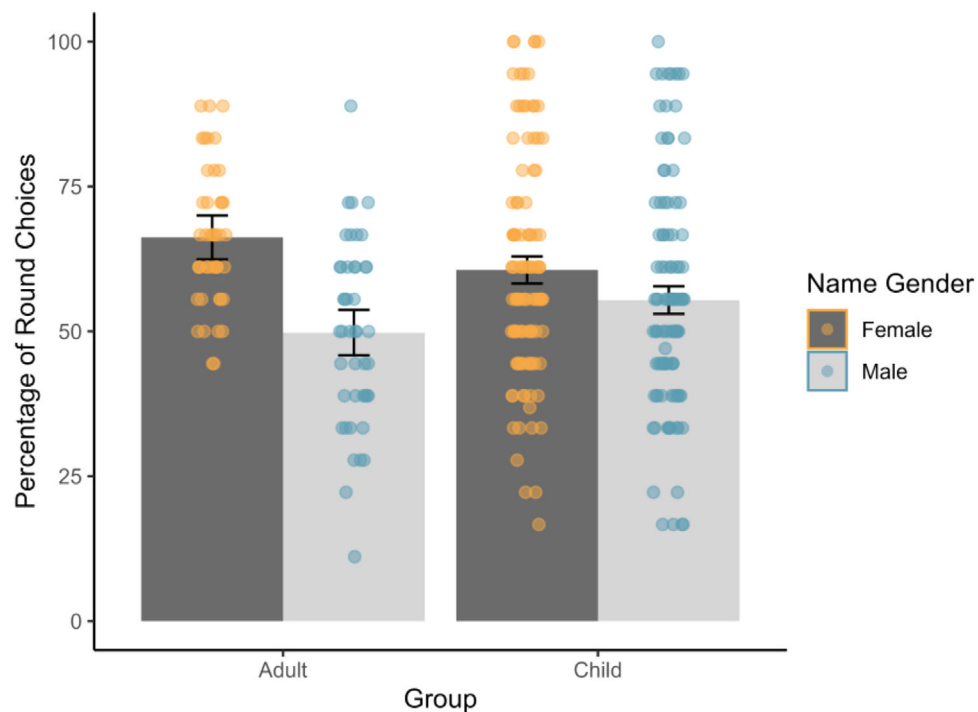


FIGURE 4 | Percentage of round choices by name gender and participant group. Subject means are plotted. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

for female names (see Figure 6). Statistics from the resulting model are shown in Table 3. See online [supplementary material](#) for a version of these analyses which included a continuous measure of name shape- and gender-associations (see Tables S4 and S5).

3.3 | Developmental Analyses of Child Participants

We proceeded with analyses of the child participants' data, to more closely examine age-related changes in name sound

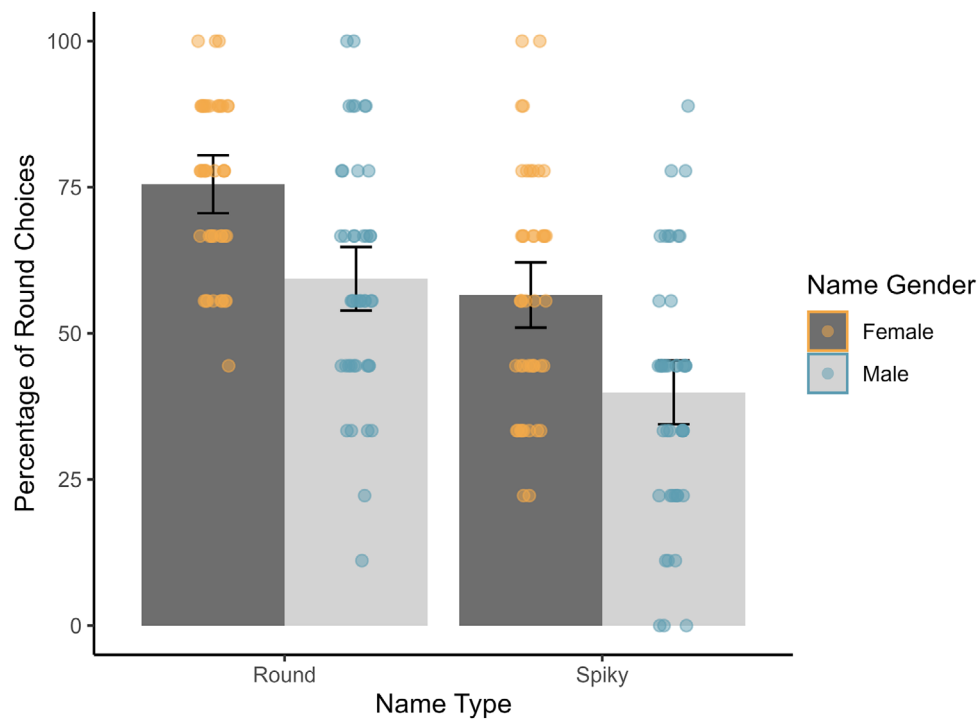


FIGURE 5 | Percentage of round choices by name type and name gender in adult participants. Subject means are plotted. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

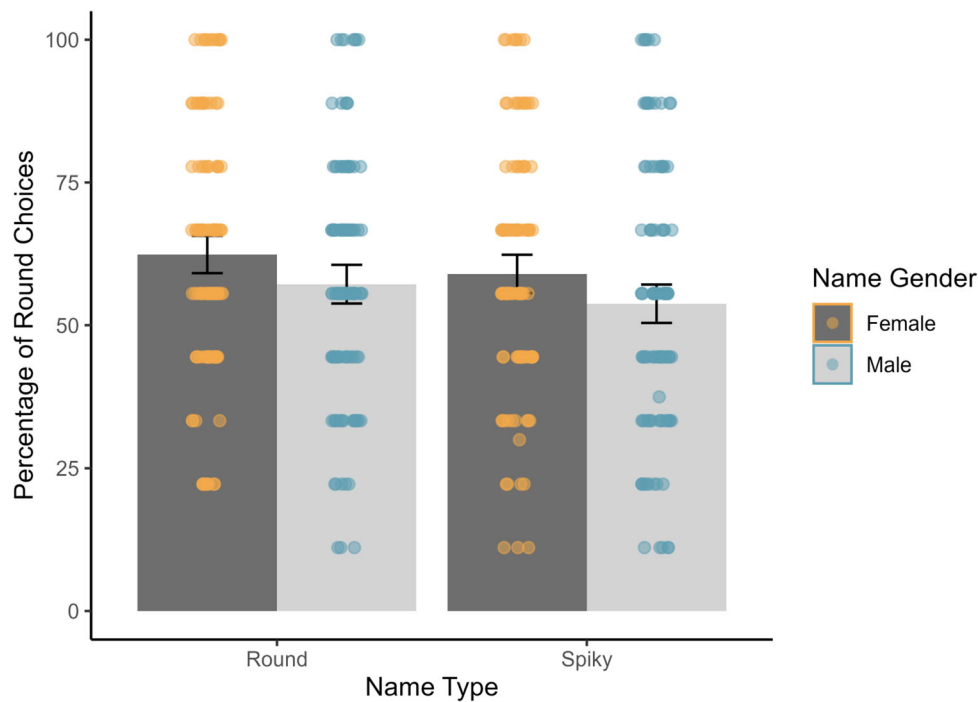


FIGURE 6 | Percentage of round choices by name type and name gender in child participants. Subject means are plotted. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

symbolism and gender-shape associations. Our first analysis included the fixed effects of name type, name gender, and age (in months), as well as interactions between name type and age, and name gender and age. Neither the interaction between name type and age ($B = 0.03$, 95% CI $[-0.12, 0.18]$) nor name gender and age ($B = -0.03$, 95% CI $[-0.19, 0.13]$) were statistically credible (see

Figures 7 and 8).⁴ This revealed that neither name sound symbolism nor gender-shape associations change significantly in this age range. Statistics from the resulting model are shown in Table 4.

Next, we examined whether either of our language measures were predictive of name sound symbolism development. We first

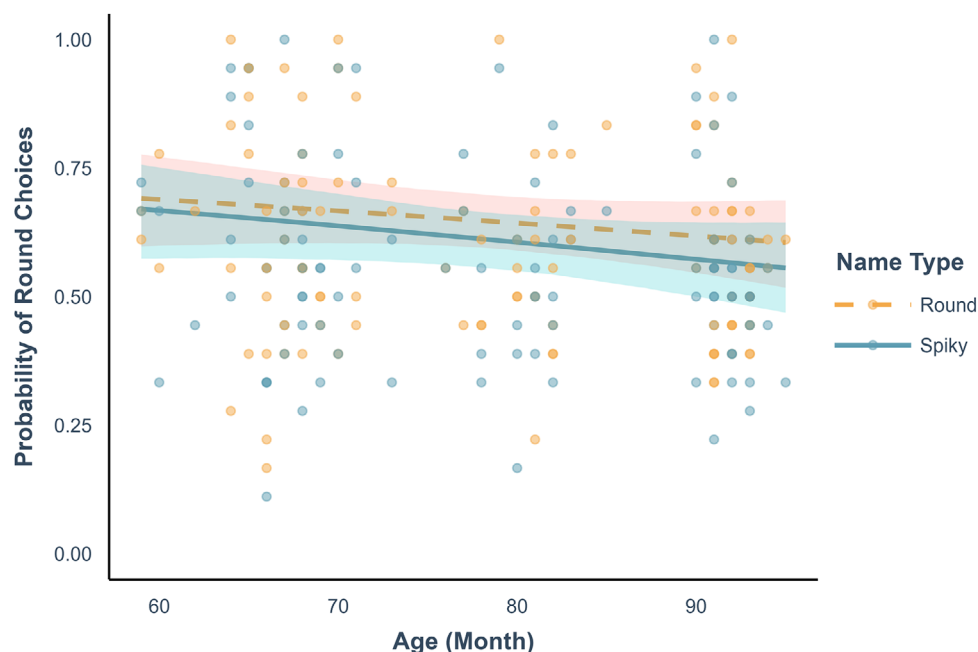


FIGURE 7 | Percentage of round choices by name type and age in child participants. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

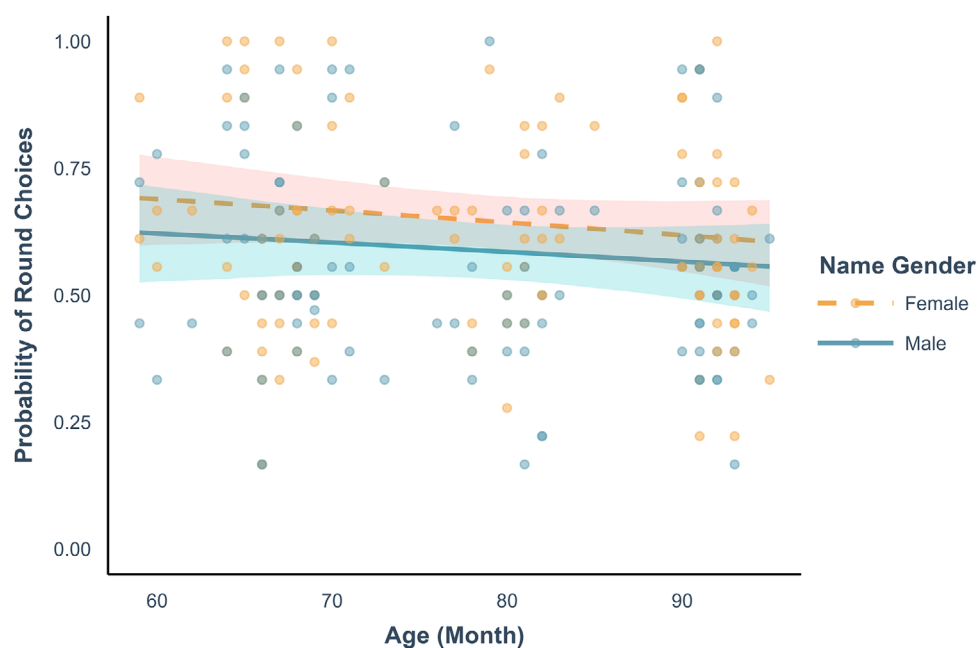


FIGURE 8 | Percentage of round choices by name gender and age in child participants. Error bars represent 95% confidence intervals computed using the method outlined by Cousineau (2005) to account for the between-subject variability.

fit a model that included name type, gender, PPVT-4 and the interaction between name type and PPVT-4 as fixed effects. There was not a statistically credible interaction between PPVT-4 score and the effect of name type ($B = -0.04$, 95% CI $[-0.19, 0.10]$; see Figure 9). Statistics from the resulting model are shown in Table 5. We next ran a version of the same model including CCC-2 instead of PPVT-4. We did not find a statistically credible interaction between CCC-2 score and the effect of name type ($B = -0.03$, 95% CI $[-0.18, 0.12]$; see Figure 10). Statistics from the resulting

model are shown in Table 6. Supplementary analyses including CCC Semantics subscale, Speech subscale, and pragmatics score also did not find an interaction with name type ($B = -0.00$, 95% CI $[-0.14, 0.15]$; $B = -0.10$, 95% CI $[-0.25, 0.05]$; $B = -0.05$, 95% CI $[-0.20, 0.10]$). Note that pragmatics scores were computed using the sum of the scaled scores for Initiation, Scripted Language, Context, and Nonverbal Communication subscales (Bishop 2013). Statistics from the resulting models are shown in online supplementary material (see Tables S1–S3).

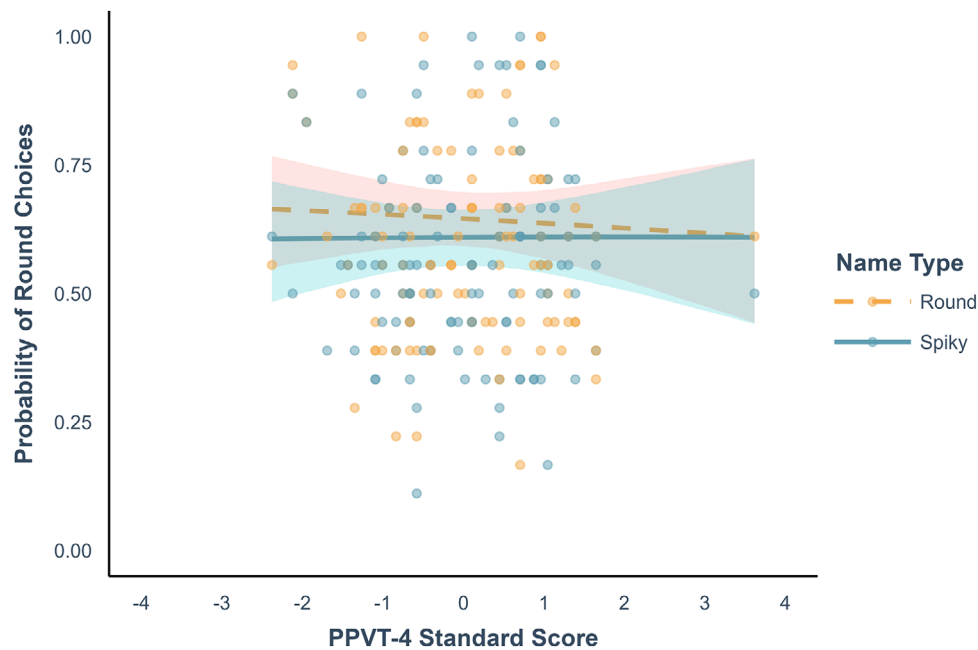


FIGURE 9 | Probability of round choices by name type and PPVT-4 in child participants. The probability with which child participants selected the round alien silhouette as the best match for round-sounding and spiky-sounding names across language skill measured by PPVT-4. Confidence bands represent 95% confidence intervals.

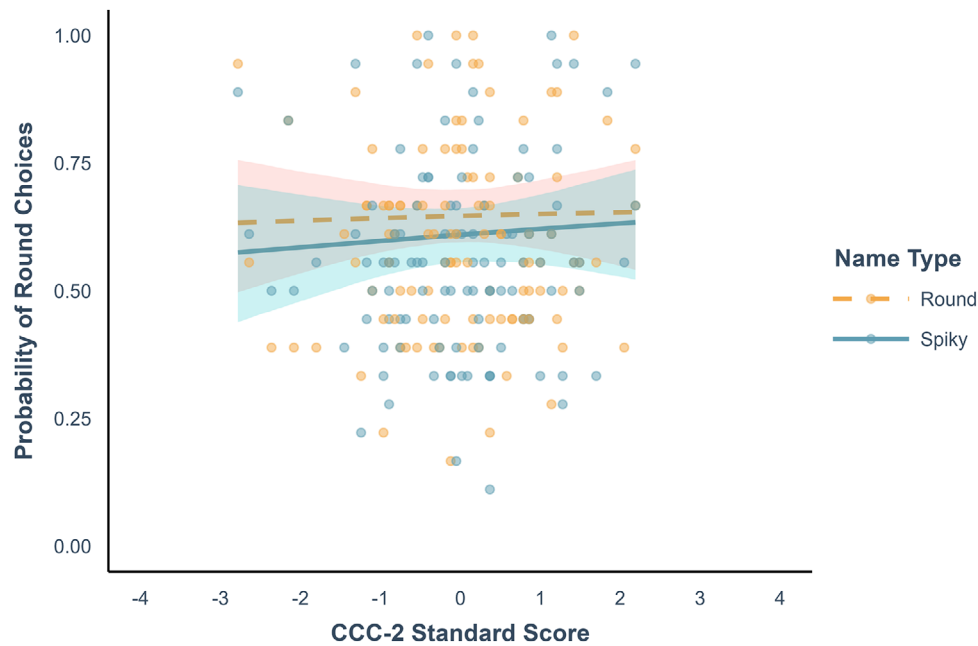


FIGURE 10 | Probability of round choices by name type and CCC-2 in child participants. The probability with which child participants selected the round alien silhouette as the best match for round-sounding and spiky-sounding names across language skills measured by CCC-2. Confidence bands represent 95% confidence intervals.

4 | Discussion

Sound symbolism refers to the association between phonemes and semantic and/or perceptual properties. A well-known example is the maluma/takete effect where round-sounding consonants and vowels are associated with round shapes, whereas spiky-sounding consonants and vowels are linked to

spiky shapes. This association has been shown to extend to real first names (i.e., *name sound symbolism*; Sidhu and Pexman 2015). Since names are associated with some amount of existing information (e.g., episodic information, gender), name sound symbolism provides additional insights into the ways in which sound symbolism operates in real words. Sidhu and Pexman (2015) further found an association between

TABLE 1 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection by group, name type, and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.37	0.07	[0.23, 0.52]*
Name type	0.53	0.09	[0.34, 0.71]*
Name gender	0.51	0.10	[0.31, 0.72]*
Group	−0.03	0.14	[−0.31, 0.25]
Name type x Group	0.74	0.16	[0.44, 1.06]*
Name gender x Group	0.53	0.17	[0.19, 0.88]*
Random effect	Intercept	SE	95% CIs
Subject intercept	0.66	0.06	[0.56, 0.78]*
Item intercept	0.24	0.05	[0.14, 0.35]*

*95% credible interval (CI) does not include zero.

TABLE 2 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection in adults by name type and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.36	0.08	[0.20, 0.53]*
Name type	0.90	0.19	[0.55, 1.27]*
Name gender	0.79	0.20	[0.40, 1.20]*
Random effect	Intercept	SE	95% CIs
Subject intercept	0.18	0.09	[0.01, 0.37]*
Item intercept	0.15	0.09	[0.01, 0.34]*

*95% credible interval (CI) does not include zero.

TABLE 3 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection in children by name type and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.40	0.09	[0.21, 0.58]*
Name type	0.16	0.09	[−0.02, 0.33]
Name gender	0.25	0.10	[0.06, 0.45]*
Random effect	Intercept	SE	95% CIs
Subject intercept	0.80	0.08	[0.66, 0.95]*
Item intercept	0.19	0.07	[0.05, 0.32]*

*95% credible interval (CI) does not include zero.

female names and round shapes, and male names and spiky shapes.

In the present study we investigated developing sensitivity to name sound symbolism, as well as the development of gender-shape associations, in 5- to 7-year-old children. We considered individual differences in language skills as a potential factor.

TABLE 4 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection in children by age, name type, and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.40	0.09	[0.21, 0.58]*
Name type	0.16	0.09	[−0.02, 0.33]
Name gender	0.25	0.10	[0.06, 0.45]*
Age	−0.12	0.09	[−0.29, 0.05]
Name type x Age	0.02	0.07	[−0.12, 0.18]
Name gender x Age	−0.03	0.08	[−0.19, 0.13]
Random effect	Intercept	SE	95% CIs
Subject intercept	0.80	0.08	[0.66, 0.95]*
Item intercept	0.19	0.07	[0.05, 0.32]*

*95% credible interval (CI) does not include zero.

TABLE 5 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection in children by PPVT-4, name type, and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.40	0.09	[0.22, 0.58]*
Name type	0.16	0.09	[−0.02, 0.33]
Name gender	0.25	0.10	[0.06, 0.45]*
PPVT-4	−0.02	0.09	[−0.19, 0.16]
Name type x PPVT-4	−0.04	0.07	[−0.19, 0.10]
Random effect	Intercept	SE	95% CIs
Subject intercept	0.80	0.08	[0.66, 0.96]*
Item intercept	0.20	0.06	[0.06, 0.32]*

*95% credible interval (CI) does not include zero.

TABLE 6 | Summary of Bayesian mixed effects logistic regression predicting the likelihood of a round silhouette selection in children by CCC-2, name type, and name gender.

Fixed effect	Coefficient	SE	95% CIs
Intercept	0.40	0.09	[0.23, 0.58]*
Name type	0.16	0.09	[−0.03, 0.34]
Name gender	0.25	0.10	[0.06, 0.45]*
CCC-2	0.03	0.09	[−0.14, 0.21]
Name type x CCC-2	−0.03	0.08	[−0.18, 0.12]
Random effect	Intercept	SE	95% CIs
Subject intercept	0.80	0.08	[0.66, 0.97]*
Item intercept	0.20	0.07	[0.04, 0.32]*

*95% credible interval (CI) does not include zero.

Our initial analysis including all participants showed that the effects of name type and name gender were both larger in adults than in children. When examining adults and children as separate groups, we found an effect of name sound symbolism in adults but not in children. However, gender-shape associations were observed in both adults and children. Lastly, the effects of name sound symbolism did not differ by child age, nor by child language skill.

4.1 | Name Sound Symbolism

We found a stronger name sound symbolism effect in adults than in children. This finding is consistent with previous studies with nonword stimuli testing children between 2 and 8 years of age (Chow et al. 2021; Maurer et al. 2006). This suggests that additional development between middle childhood and adulthood contributes to sound symbolism sensitivity. Note that the two language measures we used did not predict the strength of name sound symbolism in children, suggesting that this emerging sensitivity is not related to vocabulary or communication ability, at least in the age range tested. This finding is inconsistent with the proposal that experience with patterns in language serves to strengthen sound symbolism. As such, language patterns may not be the mechanism underlying shape sound symbolism, with other mechanisms (e.g., resemblance or shared affective properties) being more likely.

The most important contribution of the present work is to show that name sound symbolism emerges later than nonword sound symbolism. That is, while previous work has shown attenuation of sound symbolism in children (Chow et al. 2021; Maurer et al. 2006), the present results instead found no credible evidence of name sound symbolism in children by age 7. This suggests that there are additional developmental milestones required for name sound symbolism, in addition to those required for malumataketete-type nonword sound symbolism. For instance, the set of targets that 5-year-olds children list as “nameable” is more restrictive than that of adults, containing mostly living animate objects and their surrogates (Hall et al. 2004). Perhaps there are two sets of developmental milestones required for name sound symbolism: those required for sound symbolism in general, and those required specifically for name sound symbolism.

Sound symbolism with names is typically weaker than that with nonwords (Sidhu et al. 2016; Sidhu and Pexman 2015). Indeed, while adults tend to match nonwords with congruent shapes 80% of the time over multiple trials, here adults only made congruent pairings on approximately 60% of trials. There are several factors that could contribute to this. The alien shape stimuli were only slightly different in visual features between round and spiky silhouettes. As such, the shape difference in an alien silhouette pair may be subtle for participants. However, because Nielsen and Rendall (2011) found a congruent pairing rate of 81% with an equally (if not more) subtle manipulation of shape, we do not believe this to be the case.

Instead, the weaker effect of name sound symbolism may be due to the name stimuli. With real names there is an opportunity for prior associations to affect decisions. This would likely manifest as random variation, bringing the percentage of congruent pair-

ings closer to chance. Framing the task as a name task might have focused participants' attention on non-sound features of the names. One way to test this possibility could be to use nonwords (rather than names) as stimuli. Indeed, a previous study showed that using invented names does enhance effects of sound (Experiment 4; Sidhu et al. 2019). In addition, our linguistic stimuli contained more neutral phonemes than nonwords typically do in sound symbolism studies. For instance, the round-sounding name “Shane” contains the consonant /ʃ/ in addition to /n/. This is in contrast to a nonword like “maluma” which contains only round-sounding consonants. We might further speculate that this difference would be particularly impactful for children, who are still developing their phonological skills.

When analyzing only child participants, our results showed that sensitivity to name sound symbolism did not differ with age. This may be due to our small age range. A three-year range may be too restricted to capture development in these associations. The absence of age-related differences, combined with the absence of a name sound symbolism effect in children, suggests that name sound symbolism emerges gradually, likely becoming observable after 7 years of age. Future studies might benefit from examining older children.

In the present study children's sensitivity to name sound symbolism did not depend on their semantic (PPVT-4) nor pragmatic (CCC-2) language abilities. Although sound symbolism involves associations with semantics, this phenomenon is rooted in the properties of individual phonemes and their acoustic characteristics (Knoeferle et al. 2017; Sidhu et al. 2022). That is, individuals must be capable of detecting differences at the phoneme level to effectively utilize these phonological cues for deriving meanings in words. Future research might investigate individual differences in speech perception and phonemic awareness.

Indeed, previous research suggests that phoneme awareness is not fully developed until early elementary school years or until 7–8 years of age (Anthony and Francis 2005; McMurray et al. 2022). Prior to first grade, other linguistic cues in words such as syllables and onsets, rather than phonemes, serve as more readily accessible units for language processing (Fowler 1991). Since phonemic awareness is still developing in children, their ability to detect subtle phonological differences in words may be less robust than in adults. As a result, adults may be more sensitive to phonological information in people's names than children are, which may underlie the stronger effect of name type we observed in adults.

There may be other individual factors that are influential in the development of associations between phonemes and shapes. For instance, the ability to understand metaphor may underlie the difference in sensitivity to these associations between adults and children. Metaphor comprehension is still developing around ages 11 and 15 (Carriedo et al. 2016), suggesting that adults may be more skilled in metaphorical reasonings and in turn exhibit a stronger sensitivity to associations between name, gender, and shapes. However, note that children's CCC-2 pragmatic score did not predict their sensitivity to sound symbolism. Nevertheless, future studies may investigate whether certain high-level cognitive abilities play a meaningful role in contributing to the developing sensitivity to sound symbolism.

4.2 | Gender-Shape Association

We found gender-shape associations in both adults and children. Specifically, female names were more likely to be matched with round shapes, and male names were more likely to be matched with spiky shapes. This finding is consistent with results from previous studies on gender-shape associations (Blazhenkova and Kuman 2018; Sidhu and Pexman 2015; Stroessner et al. 2020). Our study provides additional evidence for the gender-shape association in children.

Notably, the gender-shape association was stronger in adults than in children. In the introduction we reviewed theories that suggest this gender-shape association could arise from the different patterns of male and female bodies in the world, the types of toys that boys and girls are encouraged to play with (i.e., statistical co-occurrences), and/or the personalities ascribed to round and spiky shapes (i.e., shared affective qualities). We tentatively suggest that a stronger gender-shape association in adults is most consistent with an explanation based on statistical co-occurrence in typical body shapes of either gender. This association may be strengthened in adults because of their greater experience observing this regularity in the world.

Gender-shape associations seem to appear at an earlier age than name sound symbolism. This is not surprising, as gender is an especially salient property for children (Kuhn et al. 1978; Miller et al. 2009; Ruble et al. 2007; Signorella et al. 1993). This highlights a developmental progression in how children process and interpret various cues in names. It is also notable that adults showed a numerically larger effect of sound symbolism than gender, suggesting that the gender of a name is not always a stronger cue.

4.3 | Sound Symbolism in Existing Words

The interplay of gender and sound in names provides insight into sound symbolism more generally. Recall that research in name sound symbolism was sparked by an interest in sound symbolism for existing linguistic stimuli. Westbury (2005) proposed that sound symbolism operates differently in existing linguistic stimuli. Indeed, while some studies have shown an effect of sound symbolism for real words in semantic categorization tasks (Aryani and Jacobs 2018), others have not (Sidhu and Pexman 2022). This attenuated effect of sound symbolism for real words is presumably due to the presence of additional sources of information beyond words' sounds (i.e., their meanings). Name sound symbolism is an interesting datapoint in this discussion. Although names do not have meanings per se, they do have associated episodic information, and provide a variety of socio-cultural cues (e.g., to gender, race, age). Our results are consistent with the suggestion that these additional sources of information can attenuate effects of sound symbolism. This provides an illustration of the complexity of sound symbolism in existing stimuli.

The multiple cues present in names might also explain the lack of name sound symbolism in children. That is, instead of name sound symbolism requiring additional development, perhaps the competing cue of gender simply overshadowed any effect of the

names' sound in children. Conversely, adults may be better able to attend to both sources of information at once. This suggests an interesting direction for future research. If gender information does compete with sound symbolism when processing names, and in turn attenuates name sound symbolism in children, then we would expect a name sound symbolic effect in children when gender-neutral names are presented.

Taken together, the attenuated effect of name sound symbolism (vs. previous findings for nonword sound symbolism) in both adults and children has important implications for understanding how sound symbolism functions in real words versus nonwords. It highlights how non-phonological factors may override the phonological cues in existing words. Given the complex interplay between existing social and cultural associations in names and phonology in names, studying names offers a promising and underexplored avenue for advancing our understanding of the sound symbolic phenomenon.

4.4 | Limitations and Future Directions

There were several limitations of the present study. First, the analyses did not account for participants' pre-existing associations with specific names. Familiarity with a name through personal relationships may activate cultural or stereotypical associations with individuals, beyond phonological cues (Barton and Halberstadt 2018; Sidhu and Pexman 2015; Zwebner et al. 2017). Some child participants reported avoiding spiky shapes due to negative prior encounters with spiky objects. This suggests another way in which individual experiences may have influenced responses. Future research could assess and control for this potential confounds to better isolate the phonological basis for sound-shape mappings.

Second, our auditory stimuli were recorded by a male speaker. Because gender was a variable of interest, it would be prudent to examine the effect of speaker gender by examining if these results generalize to audio recordings with a female speaker. Additionally, there was some non-significant variability in the acoustic properties of the name stimuli (e.g., variation in amplitude; see Fort and Schwartz 2022), which may have also influenced participants' associations. Previous work has demonstrated that acoustic properties impact associations with sound (e.g., Aryani et al. 2020; Lacey et al. 2020). As such, future studies employing auditory stimuli could benefit from accounting for these properties to better separate phonological effects from broader acoustic influences.

Third, instead of comparing to chance (i.e., choosing the round silhouette 50% of the time), we elected to compare the chances of choosing the round silhouette between round- and spiky-sounding names. Our analyses were informed by previous research with a similar design, where participants showed an overall bias toward choosing round shapes (Sidhu and Pexman 2015; Sidhu et al. 2016). Moreover, research has suggested a general preference for curved versus angular shape (Bar and Neta 2006; Chuquichambi et al. 2022; Gómez-Puerto et al. 2016). This means that 50% performance may not represent a true baseline of chance performance because people are generally more likely to choose the round silhouette. A potential direction for future

research would be to use neutral names (i.e., those that are neither perceptually round nor spiky) as a control group. This design can provide an estimate of baseline performance and help distinguish general round shape preferences from the specific effects of sound-shape associations.

Lastly, since our power analysis did not account for interactions in the models, we may have limited power to detect interaction effects. Hence, findings based on interaction results should be interpreted with caution. Future studies should include larger samples to replicate findings in the current study.

5 | Conclusions

This study highlights children's developing associations to the sounds of a name. We found that while adults showed effects of both name sound symbolism and gender-shape association in name-silhouette pairings, children only showed an effect of gender. This finding suggests that name sound symbolism emerges after 7 years of age. Our findings point to the possible interplay of phonological, semantic, and social factors in real-word sound symbolism.

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The authors have nothing to report.

Conflicts of Interest

The authors have no known conflict of interest to disclose.

Data Availability Statement

The data that support the findings of this study are openly available in the Open Science Framework: <https://osf.io/bq2jt/>.

Endnotes

¹ Alternatively, another proposal is that it is instead a resemblance between the shapes of the lips as certain phonemes are articulated (e.g., round for /o/) and objects. While a recent study failed to find any evidence of this in adult participants (Sidhu and Vigliocco 2023), it is still possible that this mechanism plays a role in children.

² Note that because this simulation could not customize the optimizer nor number of iterations, 57 of these simulations resulted in singular fits.

³ Note that while the difference in mean amplitude is approaching significance, the pattern is such that female names are higher in amplitude, which leads to the opposite expectation of what was observed if amplitude were causing the results (i.e., higher amplitude was associated with spikiness, while female names were associated with roundness; Lacey et al. 2020).

⁴ The pattern is the same if age is treated as a dummy coded categorical variable for age in years, with 5-year-olds as the reference level.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting File 1: desc70107-sup-0001-SupMatt.docx