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ORIGINAL ARTICLE

Sound-symbolism: A Piece in the Puzzle of Word Learning

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Abstract Sound-symbolism is the idea that the relationship between word sounds and word meaning is not arbitrary for all words, but rather that there are subsets of words in the world's languages for which sounds and their symbols have some degree of correspondence. The present research investigates sound-symbolism as a possible route to the learning of an unknown word's meaning. Three studies compared the guesses that adult participants made regarding the potential meanings of sound-symbolic and non-sound symbolic obsolete words. In each study, participants were able to generate better definitions for sound-symbolic words when compared to non-sound symbolic words. Participants were also more likely to recognize the meanings of sound symbolic words. The superior performance on sound-symbolic words held even when definitions generated on the basis of sound association were eliminated. It is concluded that sound symbolism is a word property that influences word learning.

Keywords Sound symbolism · Vocabulary development · Word learning

For decades, researchers in the area of vocabulary acquisition have been faced with the question of how people learn new words. The answer to this question has proved to be complex as there are several contributors to vocabulary acquisition. Research has suggested that one source, word learning within written and oral context, accounts for the majority of word learning (Nagy, Anderson, & Herman, 1987; Nagy, Herman, & Anderson, 1985). In addition, empirical evidence has shown that properties of unknown words such as concreteness (Choi & Gopnick, 1995; Schwanenflugel, Stahl, & McFalls, 1997; Schwanenflugel, 1991) and grammatical part of speech (Schwanenflugel et al., 1997) can influence word learning.

The question of phonology's place in word learning, however, has been virtually ignored based on the long-held belief among scholars of language that languages are made up of arbitrary sounds that come together to create words. In his book a *Course in General Linguistics*,

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Saussure (1959) wrote "the bond between the signifier and the signified is arbitrary" (p. 67). Over the years, however, a minority of linguists and anthropologists have come to question this belief and have begun studying the linguistic phenomenon of *sound symbolism*. Sound-symbolism is the idea that the relationship between phonology and semantics is not always arbitrary and that for *some* words present in today's languages there is a correspondence between sound and meaning (Hinton, Nichols, & Ohala, 1994). The purpose of the present research is to ascertain whether word learners can capitalize on this systematic feature of words to facilitate their semantic understanding of an unknown word.

Linguists and anthropologists have studied the phenomenon of sound-symbolism and its presence in language extensively, (Brown, Black, & Horowitz, 1955; Ciccotosto, 1991; Hinton et al., 1994; Markel & Hamp, 1960; Sapir, 1929) yet its place in general word learning has, to our knowledge, never been directly examined. A non-arbitrary relationship between word sounds and word meaning could be providing word learners with clues to the meanings of unknown words. Sound-symbolism could be another word property that aids word learners faced with numerous possible meanings for an unknown word, helping them select one meaning.

Empirical examination of the phenomenon of sound-symbolism began with the work of noted linguist Edward Sapir. Sapir (1929) explored what he called "phonetic symbolism," a type of expressive symbolism that speakers use in the field of speech dynamics (stress and pitch) and phonetics. Sapir's work motivated others to study the possibility of a non-arbitrary correspondence between word sounds and word meaning. This line of research has since come to be known predominantly as "sound symbolism, a non-arbitrary, one-to-one relation between acoustic and motor-acoustic [word] features and meaning . . ." (Ciccotosto, 1991, p.1).

Very early in the study of sound symbolism, Sapir (1929) examined English speakers' impressions of the symbolic magnitude of different vowels and consonants. For this work Sapir used invented word pairs built on a consonant, vowel, consonant model and had participants select the non-word that represented the *large* and *small* variety of some arbitrarily selected meaning. For example, the words *mal* and *mil* were used to represent small versus large tables. Sapir showed that English speakers intuitively felt that the vowel *a* was symbolic of greater magnitude than the vowel *i*, with participants believing that *mil* referred to the small table and *mal* referred to the large table.

More recently studies have examined the link between the phonology of names and a referent's gender and how children use phonological information to infer grammatical class. Cassidy, Kelly, and Sharoni (1999) found that English-speaking adults know and can use gender appropriate pronouns for pseudo-names containing stress and final phoneme phonological cues to gender. They also found that in this century the evolution of names has been affected by phonological cues which result in male or female "sounding" names, and that this information can be used to structure brand names for product marketing.

Cassidy and Kelly (2001) showed that children understand the relationship between a word's grammatical category and the number of syllables it contains. They found that children thought that tri-syllabic words were nouns and mono-syllabic words were verbs, a pattern consistently found in English. In addition, Kelly (1992) has presented several other "phonological correlates of grammatical class" (p. 351). Two such correlates in English are the pattern of stressed open class words versus non-stressed closed class words and nouns more often containing back vowels versus verbs more often containing front vowels.

Other evidence to support the existence of sound symbolism has been obtained by compiling sound symbolic features from existing languages. English has been shown to be plentiful in examples of sound symbolism. Bloomfield's (1933) book entitled *Language* included this list of sound symbols present in English:

[fl-] 'moving light': *flash, flare, flame, flick-er, flimm-er.*
[gl-] 'unmoving light': *glow, glare, gloat, gloom,* (*gleam, gloam-ing, glimm-er*).
[sl-] 'smoothly wet': *slime, sluch, slop, slobb-er, slip, slide.*
[kr-] 'noisy impact': *crash, crack,* (*creak*), *crunch.*
[skr-] 'grating impact or sound': *scratch, scrape, scream.*
[sn-] 'creep': *snake, snail, sneak, snoop.* (p. 245)

Other examples of English sound symbolism are not hard to come by. Just a few minutes of brainstorming can produce other examples of sound symbolism in English that could easily be added to Bloomfield's (1933) list. Consider the words *swirl, swivel, swift, swig, sweep, swallow, swarm, swim, swing, swipe, switch, swoosh, swoop, swill* and *swoon.* These words all bring to mind the idea of a swift, swaying movement, which suggests that [sw-] might also be an English sound symbol.

Not only is sound symbolism prominent in English but it seems to be ubiquitous throughout the world's languages. Ciccotosto (1991) acquired language samples from 229 languages, representing 10 of the 17 human language phyla, searching for examples of sound symbolism in languages around the world. He found that there was evidence of sound symbolism in almost all the phyla he studied, with its absence in some phyla explained by a lack of data or an ill-defined definition of sound symbolism.

It has been theorized that sound symbolism was present in primordial languages as well. In fact, one anthropologic theory holds that verbal language began by matching sound and meaning and that the earliest forms of human verbal language always matched sound and meaning (LeCron Foster, 1978). To test this idea, LeCron Foster performed a reconstruction of early human language and showed that "phememes," defined by her as the smallest linguistic unit that combines the features of sound and meaning, were present in primordial languages.

LeCron Foster's phonemic argument suggests that sometime around 50,000 to 75,000 years ago, there was a huge refinement of the semantic and syntactic base of primordial languages. There was also an increase in the complexity of primordial languages, which led to an expansion of the languages. This expansion resulted in a change in the phonological base. The phonological base did not expand; instead, meaning was separated from sound (LeCron Foster, 1978). It was this separation of sound and meaning which created the seemingly arbitrary relationship between the signifier and the signified that we have in present day languages. The extensive amount of evidence for sound-symbolism's presence in today's languages, however, shows that this separation of sound and meaning was incomplete. As noted by Ciccotosto (1991)

> Sound symbolism, under the phememic hypothesis, is based upon gestural cues. Sound carries meaning insofar as it references motor sequences within the hearer's mind, iconically representative of expressed behavior and activity. Conceivably, there is a substratum of this cognitive process present today in all languages. In addition, language learning could be activated with the aid of ... acquired knowledge of the phememe (p. 104).

Based on the evidence collected by Ciccotosto, there does seem to be a substratum of sound symbolism present in many of today's languages.

In the study of sound-symbolism there is also a much-heated debate as to whether sound symbols are universal or language-specific (see Hinton et al., 1994; Malkiel, 1990). Roger Brown in his 1958 book *Words and Things* noted that "while there is obviously a community, or language-specific, sound symbolism, the fact of a universal sound symbolism, one which operates across all human languages, ... [is] at best difficult to show to exist" (as cited in Kess, 1992, p. 62). Given this, the present paper argues neither for nor against sound symbols as universal or language-specific.

The purpose of this paper is to examine the possibility that sound-symbolism may have a role in word learning. This purpose can be served so long as one accepts the statement of Roger Brown (1958) that "there is obviously a community, or language-specific, sound symbolism" (as cited in Kess, 1992, p. 62). A language-specific sound-symbolism would simply mean that knowledge of sound-symbolism in one language would facilitate the learning of only that particular language. To legitimize the study of sound symbolism as a means by which people learn language, it also needs to be accepted that sound-symbolism is a phenomenon present in most of the world's languages. Sound-symbolism's presence in only a small percentage of languages would mean that it is not available for most people as a means of language learning. The evidence gathered to date suggests that, at the very least, sound-symbolism is language-specific and that it is a phenomenon of most of the world's languages (Ciccotosto, 1991). Given the acceptance of these two claims, sound-symbolism could prove to be a possible route to the learning of semantic level word information.

The present research examines the question of sound-symbolism's place as a potential feature of words that may help word learners ascertain the meaning of an unknown word. Three studies using adult participants were conducted that compared the word meanings inferred from sound-symbolic and non-sound symbolic obsolete words. In each study, we took the point of view that knowledge of a word's meaning is not on an all-or-nothing scale. Durso and Shore (1991), Shore and Durso (1990) and Schwanenflugel et al. (1997) have argued that knowledge of a word's meaning varies from total lack of knowledge, to partial knowledge, to full knowledge. A person may feel that they do not *know* the meaning of a word, but still be able to describe its meaning in general semantic terms. Taking into account partial word knowledge may provide some advantages when examining participants' inferences as to the meanings of unknown sound symbolic words. If sound-symbolism provides real semantic information to word learners, participants should be able to guess the meanings of sound-symbolic words that suggest at least partial word knowledge.

Study 1 was an initial study examining the role sound-symbolism might play in the learning of an unknown word's meaning. Studies 2 and 3 were designed to build on the results of Study 1 to create a more reliable and valid measure of sound-symbolism's influence on word learning, ruling out potential confounds.

Study 1

Study 1 was an initial study of sound-symbolism. This study was intended to determine, in a general way, if people have more intuitive knowledge of the meanings of sound-symbolic words than non-sound symbolic words. Obsolete English words were used as stimuli to preclude the possibility that participants may have prior word knowledge. For this study, participants generated written definitions and recognized, in a multiple-choice test, the definitions of 20 sound-symbolic and 20 non-sound symbolic obsolete English words presented in isolation, with no surrounding context. If sound-symbolism can help word learners infer the meaning of an unknown word, then participants should show better performance on the sound-symbolic words when compared to the non-sound symbolic words.

Method

Participants

Thirty adult participants were used in Study 1. Seventeen of these participants were university undergraduates and 13 were recruited from the local community. All participants were native English speakers. The university undergraduates were all enrolled in introductory psychology classes and their participation in this experiment fulfilled part of the requirements for their psychology class.

Stimuli

Stimuli for all participants in Study 1 consisted of 20 sound-symbolic and 20 non-sound symbolic obsolete English words. These words are presented in Tables 1 and 2. Obsolete words were used in an attempt to control for prior word knowledge. English words were used so that the native English-speaking participants could use their knowledge of English and English sound symbols to help them define the presented words.

Table 1 Sound-symbolic stimuli

Sound	Symbol	Study 1	Study 2	Study 3
[cl-]	"a loud sound"		clacker	clicket
			clammas	clammas
[cr-]	"noisy impact"		craske	craske
			crunkle	crunkle
[dr-]	"watery, wet"		dreen	dreen
			drook	drook
[fl-]	"moving light"	flaucht		
	"movement in air"	flabellation		
		flang	flam	fluce
		flob	flob	flotte
[gl-]	"unmoving light"	glede	glede	glede
		glimcy	glisk	glisk
		glime		
[gr-]	"an angry manner"		grame	grame
			greme	greme
[j-]	"up and down movement"	jactitate		
		jow		
[scr-]	"grating impact or sound"	scriek	scriek	scranch
			scroop	scroop
[sl-]	"smoothly wet"	sleech	sleech	sleech
		slive	slive	slive
		sloke		
[sn-]	"breath-noise"	snite		
	"quick movement "	snaught		
	"creep"	snoke	snoke	snoke
		snoove	snoove	snoove
[st-]	"walking movement"		staffle	staffle
			strake	strake
[sw-]	"swift movement"	swaff	swaff	swaib
		swale		
		sweg	sweg	sweg
[tr-]	"effortful walking"		trig	traik
			trimple	trimple
[tw-]	"a twisting or pinching motion"		twage	twage
			twigle	twight

Table 2 Non-sound symbolic stimuli

Study 1	Study 2	Study 3
aidle		
bauch	bourd	bourd
bole	busk	busk
choile		
	ettle	ettle
	etyn	etyn
	fay	fay
	fete	fud
	goffram	goffram
	gome	gome
hent	hend	hend
	henter	henter
jimp		
kep	kexy	kexy
kith	kith	kith
lea		
leuch		
mammer	maups	maups
meare	meazy	meazy
nantle	nare	naye
	nesp	nesp
	rax	rax
reave	reave	reave
rede		
targe	targe	targe
teld	tasse	tarne
queme		
	umgripe	umgripe
	unco	unco
vade		
	welkin	welkin
	weth	weth
wode	wode	wode
	wox	wox

To select potential words to serve as sound-symbolic stimuli, a compilation of sound symbols and their meanings was made by combining the Bloomfield (1933) and Ciccotosto (1991) lists of various English sound symbols. We restricted the sound symbols used in this research to those that occupy the initial position in words. Also, the above-cited [sw-] sound was added to the list. A survey of Mackay's (1879) *The Lost Beauties of the English Language*, a dictionary of obsolete English words, was performed to obtain 20 obsolete words whose initial sounds matched those of the sound symbols and whose meanings matched the meanings of the sound symbols. A total of seven sound symbols were used from one to four times across different obsolete words. Twenty other randomly chosen obsolete English words from *The Lost Beauties of the English Language* were used as non-sound symbolic stimuli if they did not have initial sounds that matched those in the compiled list of sound symbols.

Procedure

Each participant completed two study phases designed to assess expressive and receptive knowledge of word meanings, a *guess phase* and a *recognition phase*. In the guess phase, participants were presented with the 20 sound-symbolic and 20 non-sound symbolic words in random order. Participants were asked to perform two tasks for each word presented in the guess phase. First, participants were asked to fit the word into one of Dale, O'Rourke, and Barbe's (1986) four levels of word knowledge: (1) I never saw it before, (2) I've heard of it, but I don't know what it means, (3) I recognize it—it has something to do with . . . , and (4) I know it. Then, they were asked to generate a written definition for each word.

In the recognition phase of the study, the participants were presented with the same list of words. In this phase of the study the words appeared along with several possible definitions and they were asked to choose the definition they believed best fit the listed word. The choices in the recognition phase included: (1) the correct word definition, and (2) three distractor definitions. The distractor definitions were also definitions of obsolete words randomly chosen from Mackay's (1879) *The Lost Beauties of the English Language*.

All participants completed the two phases (guess and recognition) of the study in the same order. Each participant first generated a written guess at the meaning of each word and then completed the multiple-choice phase of the study. The phases of the study were not counterbalanced to prevent the correct option in the recognition phase from priming potentially weak knowledge in the guess phase.

Scoring

Scoring for the guess phase of the study was on a 0–2 scale. A score of 2 was given for a completely correct word definition; a score of 1 was given for a partially correct word definition; and a score of 0 was given for an incorrect word definition. Laird and Agnes' (1999) *Roget's A–Z Thesaurus* was used to determine both correct and partially correct word definitions. A definition was scored as completely correct if it exactly matched the stimulus word's definition or if it was found to be a direct synonym for the definition of the stimulus word. For example, the stimulus word *glisk* means *to sparkle*. Correct definitions for *glisk* included *sparkle*, *glitter*, *glisten*, *twinkle* and *shine,* as they are listed as direct synonyms for *sparkle* in *Roget's A–Z Thesaurus*. A definition was scored as partially correct if it was an indirect synonym for the stimulus word's definition or if it had some sort of relationship with the stimulus word's definition. Partially correct definitions for *glisk* included *shimmer, bright, light,* and *mirror* as they are listed as synonyms for *shine* in *Roget's A–Z Thesaurus*. Partially correct relational definitions for *glisk* included *polish* and *clean* as they are means of making things sparkle. In instances were participants left the definition area blank or wrote, "don't know," a score of 0 was given. The scoring for the recognition phase of the study was dichotomous, with a score of 1 given when the correct definition was chosen and a score of 0 given when any of the incorrect definitions were chosen.

The first author scored all of the guess phase data. In addition, a naïve rater scored one-third of the guess phase data. A Cohen's Kappa index of interrater reliability was calculated. This index is corrected for chance agreement (Cohen, 1968) and revealed an interrater reliability of 89%.

Results

Prior to statistical analyses, participants' rankings of words, based on the Dale et al. (1986) checklist, were used to eliminate words for which participants had prior knowledge. Words that participants ranked at a knowledge level of 2 or above (any word knowledge at all), and for which the correct definition was either guessed or recognized, were eliminated from analyses. This represented 5.6% of the data.

The guess and recognition phases of the study were analyzed separately. Participants' sound-symbolic and non-sound symbolic item scores from each phase of the study were averaged. All results are reported in the metric of the scale. As noted earlier, the guess phase was scored on a 0–2 scale and the recognition phase was scored on a 0–1 scale.

Guess phase

A paired sample t-test comparing the average definition scores for the sound-symbolic words to the average definition scores for the non-sound symbolic words showed a significant effect of word type, $t(29) = 5.91$, $p < .01$. A comparison of the means revealed that the sound-symbolic words ($M = .29$) yielded more accurate word definitions than the non-sound symbolic words ($M = .07$).

Recognition phase

A paired sample t-test comparing the definitions chosen by participants for the sound-symbolic words to those chosen by participants for the non-sound symbolic words showed a significant effect of word type, $t(29) = 3.56$, $p < .01$. A comparison of the means revealed that the definitions of the sound symbolic words ($M = .39$) were recognized more often than the definitions of the non-sound symbolic word ($M = .27$).

Controlling for the influence of sound association

While scoring the guess phase of Study 1, it became apparent that many of the definitions participants generated for the sound-symbolic words contained the sound symbols themselves. For example, the most commonly generated definition for the word *scriek* was *to scream*. As *scriek* means *a cry or sound,* the generated definition *to scream* was scored as correct. It remains a question, then, as to whether the effect of sound-symbolism is simply a result of word association emanating from the initial word sound, a type of "sound association" (sometimes called "clang associations," Ervin, 1961), or whether sound-symbolism goes beyond this kind of initial sound guessing to a more fundamental meaning process.

With this question in mind a separate analysis was conducted on the guess phase data to control for the influence of sound association. For this analysis any generated definitions containing the same initial sound as the target word were removed from analysis, as these definitions may have been generated through sound association. Thus, any generated definitions containing the test sound symbols themselves were removed from analysis. It seemed reasonable to restrict ourselves to these initial sound symbols because that was the basis under which the words had been chosen. Associations made on the basis of other sounds in the target word would not have led to a correct response.

The removal of generated definitions containing the initial sound of the target word was done for both the sound-symbolic and the non-sound symbolic words, which resulted in the removal of 45% of the sound-symbolic word definitions and 31% of the non-sound symbolic word definitions. The results of this analysis revealed that there was still a significant effect of word type, $t(29) = 5.03$, $p < .01$. Without sound association the sound-symbolic words ($M = .17$) still yielded more accurate word definitions than the non-sound symbolic words ($M = .06$). Thus, the effect of sound-symbolism cannot be viewed as resulting from simple sound association. Even with this conservative analysis regarding the size of the effect, sound-symbolism continued to exert a significant effect on the guessing of potential word meanings.

Generalizability analysis

Generalizability analysis was also done on the Study 1 data to determine whether the research sample of measures is generalizable to the universe of measures from which it was drawn (Brennan, 1992). In this research, the objects of measurement are the sound-symbolic and non-sound symbolic obsolete English words. Generalizabilty analysis was used to determine if this sample of words is generalizable to the larger universe of obsolete English words. It should be noted that the results of a generalizability analysis are a generalizablity and reliability coefficient that, if greater than .70, support the claim that the sample measures are generalizable to the larger universe of measures.

Data for the generalizability analysis done in this research were obtained by adding together the scores for the guess and recognition phases of the study for all 40 words to create one total word score for each word. This simplification of the analysis was acceptable as the analysis was only intended to determine the overall items' generalizability to other obsolete English words. How the items performed in the guess and recognition phases of the study was not of particular concern. Thus, each item entered into the GENOVA program (Crick & Brennan, 1984) for generalizabilty analysis had a total score that ranged in value of 0–3, with a maximum score of 2 from the guess phase and 1 from the recognition phase.

Analysis of the Study 1 data resulted in a generalizability coefficient of .86 for the sound-symbolic words and .81 for the non-sound symbolic. A reliability coefficient of .84 was found for the sound-symbolic words and .80 for the non-sound symbolic words. Given that these coefficients exceed .70, it can be concluded that the results of Study 1 are generalizable to the larger universe of obsolete English sound-symbolic and non-sound-symbolic words, and that our effect is not simply a result of the words used in the scale.

Discussion

Overall, for Study 1 there was an effect of sound-symbolism in both the guess and recognition phases. The finding of such a strong effect of sound-symbolism in the guess phase of this study is very promising as to sound-symbolism's usefulness in the learning of a word's meaning, as the guess phase of this study is more analogous to a real world word-learning situation than the recognition phase. In the real world, word learners must construct an unknown word's meaning using the context in which it appears and whatever features of the word itself the word learner might detect. The guess phase of this study, then, would actually be harder than a normal word-learning situation in that these words were presented in isolation, with no surrounding context from which to draw information about a possible word meaning. Participants had only the word itself from which to determine word meaning. Hence, these findings strongly implicate sound-symbolism as a word property from which word learners can draw information about the possible meaning of an unknown word. The results of Study 1 show that this effect is not a result of simple sound association with other words that share the same initial phonemic segment. The effect of sound-symbolism on word learning, then, warrants further investigation.

Study 2

As Study 1 used a fairly limited number of sound symbols repeatedly, the number of sound symbols represented in the Study 2 sound-symbolism scale was expanded. Study 1 used seven sound symbols appearing anywhere from one to four times, as this could potentially have resulted in learning effects for the sound symbols appearing the most often the Study 2 scale balanced the appearance of the sound symbols. The Study 2 scale then contained 13 sound symbols which each appeared only twice in the scale, for a total of 26 sound symbolic target words. Another potential problem with Study 1 is the fact that many of the correct choices for the recognition phase of the study contained the sound symbols themselves and thus did not control for the influence of sound association. These problems were addressed and controlled for in Study 2.

Method

Participants

Sixty-nine undergraduates completed the Study 2 sound-symbolism scale. All university undergraduates were enrolled in introductory psychology classes. Their participation in this experiment fulfilled part of the requirements for their psychology class. All participants were native English speakers.

Stimuli

Prior to creating the sound-symbolism scale used in this study, revisions of the Study 1 scale were performed to control for potential confounds and scale factors that could exaggerate the influence of sound-symbolism on the construction of word meanings. Specifically, we analyzed for item difficulty and prior word knowledge level to refine the items used in the Study 2 scale.

To ensure that an effect of sound-symbolism in the recognition phase of subsequent studies was not a function of the items included in the sound-symbolism scale, the recognition phase data from Study 1 was submitted to item analysis. The proportion of correct responses for each item was examined to determine item difficulty. Items that were too easy (received a large proportion of correct responses) or too difficult (received few or no correct responses) were removed from the Study 2 scale regardless of whether they were sound-symbolic or non-sound symbolic. This was done in an attempt to equalize difficulty between the two word types to control for any hidden bias favoring one word type over the other. This resulted in the removal of three sound-symbolic and eight non-sound symbolic words.

Further refinement of the items included in the Study 2 scale consisted of removing items known by participants. Items that were rated by participants at or above level 2 on the Dale et al. (1986) checklist and that were either guessed or recognized correctly by two or more participants were removed from the Study 2 scale. A total of six words, three sound-symbolic and three non-sound symbolic, were removed based on participants' prior word knowledge.

All words eliminated by item and knowledge level analyses were replaced by other obsolete English words obtained from Mackay's (1879) *The Lost Beauties of the English Language*. Study 2 also increased the number of initial sound symbols represented in the sound-symbolism scale from the 7 used in Study 1 to 13. The number of times each sound symbol appeared in the sound-symbolism scale was also balanced in Study 2 with each of the 13 sound symbols appearing twice in the set of targeted words. The list of sound symbols employed in Study 1, including the Bloomfield (1933) and Ciccotosto (1991) lists, was used in Study 2 to obtain these additional sound-symbolic words. One change, however, was the addition of the [tw-] sound found in Nuckolls (1999).

Because the 13 sound symbols appearing in the scale were balanced, the initial sounds for the non-sound symbolic words were also balanced. Thus, the Study 2 scale contained

13 initial non-sound symbolic sounds with 2 words per sound. Non-sound symbolic initial sounds were defined simply as sounds not appearing in the Bloomfield (1933), Ciccotosto (1991) or Nuckolls (1999) lists. This type of initial sound balancing was not done for the Study 1 scale. This scale change was intended to prevent any unusual response biases or learning as a function of a particular sound being used repeatedly in the task. The Study 2 version of the sound-symbolism scale, then, contained 26 sound-symbolic and 26 non-sound symbolic obsolete English words (see Tables 1 and 2).

All additional sound-symbolic and non-sound symbolic words were obtained in the same way as those in Study 1, except for the use of two additional obsolete English dictionaries: Halliwall's (1950) *The Dictionary of Archaic and Provincial Words* and Gramb's (1994) *The Endangered English Dictionary.* As in Study 1, the definitions used as distractors in the recognition phase were definitions of obsolete English words. In the Study 2 sound-symbolism scale, the choices in the recognition phase included: (1) the correct definition, and (2) two distractor definitions.

Another major change in the development of this revised scale occurred in the multiple-choice section. Upon examination of the choices listed for the sound-symbolic words it was observed that some of the correct word definition options contained the sound symbols present in the stimulus words. For example, the definition of the sound-symbolic word *sweg* is *to sway back and forth*; this definition contains the [sw-] sound symbol present in the target word. As this is a possible clue as to the correct answer, synonyms were used to replace definition words that contained the same sound symbol as the sound-symbolic words being tested. This change allowed for better control of sound association effects in the recognition phase. See Appendix A for a review of all synonyms used.

Procedure and scoring

The procedures and scoring used in both the guess and recognition phases of Study 2 matched those used in Study 1. As in Study 1, the first author scored all of the guess phase data. In addition, a naïve rater scored one-third of the guess phase data. A Cohen's Kappa was calculated, and revealed an inter-rater reliability of 85%.

Results

As in Study 1, words that participants ranked at a knowledge level of 2 or above and for which the correct definition was either guessed or recognized were eliminated from analyses. This represented 6.1% of the data. Thus, as in Study 1, the influence of prior word knowledge was controlled.

Guess phase

A paired sample t-test comparing the average definition scores for the sound symbolic words to the average definition scores for the non-sound symbolic words showed a significant effect of word type, $t(68) = 14.18$, $p < .01$. A comparison of the means revealed that the sound symbolic words ($M = .23$) yielded more accurate word definitions than the non-sound symbolic words ($M = .02$).

Recognition phase

A paired sample t-test comparing the definitions chosen by participants for the sound symbolic words to those chosen by participants for the non-sound symbolic words showed a significant effect of word type, $t(68) = 10.74$, $p < .01$. A comparison of the means revealed that the definitions of the sound-symbolic words ($M = .51$) were recognized more often than the definitions of the non-sound symbolic words ($M = .35$). Thus, the effect of sound-symbolism remained even after replacing multiple-choice definition options containing the sound symbols with ones that did not contain the symbols. This finding further supports the claim that sound-symbolism is not a result of simple sound association.

Controlling for the influence of sound association

As with the previous study, separate analysis was performed to control for the influence of sound association in the guess phase. For this analysis 51% of the sound-symbolic word definitions and 5.4% of the non-sound symbolic word definitions were removed from analysis based on the possibility that they may have been generated through sound association. A paired sample t-test analysis was performed on the data set containing only definitions not generated through sound association and revealed that, even with the influence of sound association removed, there was a significant effect of sound symbolism, $t(68) = 11.45$, $p < .01$. A comparison of the means showed that without sound association, sound-symbolic words ($M = .17$) still yielded more accurate word definitions that the non-sound symbolic words ($M = .03$). As in Study 1 and the recognition phase of this study, the effect of sound symbolism cannot be attributed to simple sound association.

Generalizability analysis

The data for the Study 2 generalizability analysis were generated in the same way as in Study 1. Analysis of the sound-symbolic words resulted in a generalizability and reliability coefficient of .95. Analysis of the non-sound symbolic words resulted in a generalizabilty and reliability coefficient of .82. Thus, with 26 sound-symbolic and 26 non-sound symbolic words and 69 adult participants, the words used in the Study 2 scale are generalizable to the universe of obsolete English sound-symbolic and non-sound symbolic words.

Discussion

The results of Study 2 replicated those of Study 1. There was an effect of sound-symbolism in both the guess and recognition phases. This effect of sound-symbolism was strongest in the guess phase. This effect remained in both phases of the study even when the influence of sound association was controlled. Moreover, the scores on the Study 2 scale are more reliable than those from Study 1 because of improvements made from Study 1 to Study 2. These results are also generalizable to the larger universe of obsolete English sound-symbolic and non-sound symbolic words. Thus, Study 2 supports a place for sound-symbolism in the puzzle of word learning.

Study 3

One possibility that remained for the findings of Study 2 is that, in the recognition phase, there was some hidden bias in the way the distractors were generated such that they favored the sound-symbolic words. In this study, a Distractor-Only Test was developed to ensure that the distractors used in the recognition phase of this study would function well as distractors. As in Study 2, the items used in Study 3 were refined by replacing words rated at a knowledge level of 2 or more and guessed or recognized correctly by two or more participants. Again, we replaced words that were too difficult or too easy according to the results of Study 2.

Another potential problem with the methods used in Study 2 is that participants were asked to generate definitions for many words that they patently had declared they did not know. This issue may have affected the seriousness with which the participants regarded the task and may have had unknown consequences for the size of the effects obtained. Thus, in Study 3, 13 identifiable words were added to enhance the meaningfulness of the task for participants.

Method

Participants

One-hundred-and-thirty-nine undergraduates completed the Study 3 sound-symbolism scale. In addition, 45 undergraduates completed a multiple-choice distractor test to ensure that the distractors used in the recognition phase of this study would function well as distractors. All university undergraduates were enrolled in introductory psychology classes and their participation in this experiment fulfilled part of the requirements for their psychology class. All participants were native English speakers.

Stimuli

As in the previous study item analysis was performed on the recognition phase data which resulted in the removal of three sound-symbolic words. In addition, prior word knowledge as determined by the Dale et al. (1986) checklist resulted in the removal of 10 sound-symbolic and two non-sound symbolic words. The same 13 initial sound symbols and non-sound symbols used in Study 2 were used in Study 3. These initial sounds remained balanced, two words per sound, for the sound-symbolic and the non-sound symbolic words. As before, 26 sound-symbolic and 26 non-sound symbolic words were used as stimuli (see Tables 1 and 2).

In addition, 13 identifiable words were added to the scale. The addition of these identifiable words was intended to enhance the legitimacy of the scale by giving participants several words for which they could knowingly generate a correct definition. It was believed that being presented with some identifiable words would help keep participants on task, and possibly prevent them from checking off items as known when they actually were not known. These 13 identifiable words added to the Study 3 scale were low frequency adult words that were likely to be known by most undergraduate college students. These words were not intended as a measure of skill and, as such, were eliminated from all data analyses.

As in Study 2, none of the definition choices in the multiple-choice phase contained the same sound symbols as the stimulus words to be defined. In addition, a separate multiple-choice test of distractors was created to ensure that all distractors used in Study 3 were seen as plausible definitions for stimulus words. This Distractor-Only Test contained all the words to be used as stimuli for Study 3 along with four distractor definitions for each word. None of the distractor definitions were correct word definitions, as theoretically, the correct definition for a sound-symbolic word would draw participants to choose that definition. In the Distractor-Only Test the correct word definition was eliminated to determine whether participants saw the incorrect distractor definitions as plausible definitions for the stimulus words. Thus, the Distractor-Only Test was used to obtain distractors that received a proportion of the participants' responses at the level of chance or above. Only those distractors receiving chance or above chance level responding were used in the Study 3 scale, as participants saw these as plausible definitions for the stimulus words.

The first version of the Distractor-Only Test completed by 25 undergraduates resulted in a plausible set of distractors for 48% of the items. A second version of the Distractor-Only Test was created and completed by 20 additional undergraduate students. The combination of these two test resulted in three or more plausible distractors for all stimuli used in the Study 3 scale. Thus, the Distractor-Only Test ensured that all distractors used in the multiple-choice phase of Study 3 would function well as distractors. The choices in the multiple-choice phase of Study 3 consisted of: (1) the correct word definition, controlling for the influence of sound association; and (2) three similarly distracting incorrect word definitions.

Procedure and scoring

The procedures and scoring used in both the guess and recognition phases of Study 3 matched those used in Study 1. As in the previous studies, the first author scored all of the guess phase data. In addition, a naïve rater scored one-third of the guess phase data. A Cohen's Kappa was calculated and revealed an inter-rater reliability of 87%.

Results

As in the prior studies, words that were ranked at a knowledge level of 2 or more and for which the correct definition was either guessed or recognized were eliminated from analyses. This represented 5.8% of the data in Study 3. Thus, as in the earlier studies the influence of prior word knowledge was controlled.

Guess phase

A paired sample t-test comparing the average definition scores for the sound symbolic words to the average definition scores for the non-sound symbolic words showed a significant effect of word type, $t(138) = 12.01$, $p < .01$. A comparison of the means revealed that the sound-symbolic words ($M = .18$) yielded more accurate word definitions than the non-sound symbolic words ($M = .03$).

Recognition phase

A paired sample t-test comparing the definitions chosen by participants for the sound symbolic words to those chosen by participants for the non-sound symbolic words showed a significant effect of word type, $t(138) = 13.16$, $p < .01$. A comparison of the means revealed that the definitions of the sound-symbolic words ($M = .33$) were recognized more often than the definitions of the non-sound symbolic words ($M = .20$). Thus, as in Study 2, an effect of sound-symbolism was found in the recognition phase even when the influence of sound association was controlled.

Controlling for the influence of sound association

Separate analysis was again performed on the guess phase data to control for the influence of sound association. Any definitions that may have been generated through sound association were removed from the data set for both sound-symbolic and non-sound-symbolic words. This resulted in the removal of 48% of the sound-symbolic word definitions and 26% of the non-sound symbolic word definitions. A paired sample t-test performed on the new data set containing only definitions not generated through sound association revealed a significant effect of sound-symbolism, $t(138) = 9.73$, $p < .01$. A comparison of the means showed that, without sound association, the sound-symbolic words ($M = .11$) still yielded more accurate word definitions than non-sound symbolic words ($M = .03$). Thus, as in the previous studies, the effect of sound-symbolism cannot be viewed as a result of simple sound association.

Generalizability analysis

Generalizability analysis was also carried out for Study 3. Analysis of the sound-symbolic words resulted in a generalizability and reliability coefficient of .95. Analysis of the non-sound-symbolic words resulted in a generalizabilty and reliability coefficient of .92. Thus, with 26 sound-symbolic and 26 non-sound symbolic words and 139 adult participants the results of Study 3 are generalizable to the universe of obsolete English sound symbolic and non-sound symbolic words. This analysis, then, helps validate the scores from the Study 3 scale, supporting the extension of these results to a more general set of obsolete English words.

Factor analysis

Factor analysis was performed on the item data generated in Study 3 for internal validation purposes (Benson & Nasser, 1998). For this analysis, the guess and recognition phase data for all stimulus words was combined to form one total word score for each word. These total word scores were combined into parcels based on the 26 initial sounds represented in the scale, resulting in 13 sound-symbolic and 13 non-sound-symbolic item parcels. Parcel scores ranged in value from 0 to 6. A two-factor model of confirmatory factor analysis was estimated using LISREL 8.14. Using maximum likelihood as an estimator, this two-factor model resulted in acceptable goodness of fit measures: $\chi^2(299) = 353.89$; RMSEA = .04 (.02; .05); and GFI = .83. These model fit measures along with the non-correlated factors ($r = -.067$) support the validity of the internal structure of the sound-symbolism scale used in this study as all 13 sound-symbolic item parcels factored together and all 13 non-sound symbolic item parcels factored together. Thus, the sound-symbolic words presented in this scale were seen as distinct from the non-sound symbolic words.

Discussion

Using the finalized list of sound-symbolic and non-sound symbolic stimuli, the Study 3 scale replicated the findings of the previous studies, lending more support to the idea that sound-symbolism is a possible route to the learning of an unknown word's meaning. In Study 3 there was an effect of sound-symbolism in both the guess and recognition phases of the study. This effect of sound-symbolism was strongest in the guess phase. The process of scale development that resulted in the Study 3 scale also lends support to sound-symbolism's usefulness in word learning. The reliability and validity of the Study 3 scores were found to be acceptable.

General discussion

The presented research examined the ability of adult word learners to both generate and recognize the meanings of two types of unknown words, those containing a sound symbol and those lacking a sound symbol. The results of all three studies showed that sound-symbolic words consistently yielded more accurate knowledge of word meanings than non-sound symbolic words. Participants in these studies were able to generate more correct definitions for sound-symbolic words when compared to non-sound symbolic words. They were also able to choose, in a multiple-choice format, more correct word definitions for sound-symbolic words. Sound-symbolism, then, does seem to provide adult word learners with a clue to understanding the meaning of an unknown word.

The findings from all three studies provide great support for the claim that the link between word sounds and word meaning is not completely arbitrary for all words. Indeed, in the guess phase of these studies, there were countless possible meanings for the unknown words. In this situation, the likelihood that a participant would be able to generate a correct word definition by chance was rather remote. An examination of the means of the non-sound symbolic words in the guess phases of the first three studies shows that there was a less than 4% chance of generating, by chance, a correct word definition for a random unknown word presented in isolation. For the sound-symbolic words in this research, however, there was an overall 18% chance that participants would generate a correct word definition. As the words in these studies were presented in isolation, this difference can only be attributed to the sound symbolic information present in the sound symbolic words. Thus, our findings support the idea that sound-symbolic information present in words is a possible route to the learning of new words and provide evidence for the presence of sound-symbolism in the English language.

The process of scale development implemented in this research adds further support to sound-symbolism's potential usefulness in word learning. Through scale development, prior semantic knowledge of words was controlled by eliminating words from Studies 1 and 2 known by two or more participants. Through scale development, sound-symbolic and non-sound symbolic words that were either too easy or too difficult were eliminated. The Distractor-Only Test in Study 3 eliminated ineffective distractors so that the effectiveness of distractors was similar for both word types. Moreover, factor analysis supports the internal validity of the scale, suggesting that participants' scores on the Study 3 scale reflected the two distinct word types. Lastly, the generalizablity analyses conducted on the scores from all studies supports the generalization of these scale scores to other obsolete English sound-symbolic and non-sound symbolic words. Thus, the ability of participants to use sound symbolic word information to yield greater knowledge of word meanings should not be restricted to the items used in any of these particular sound-symbolism scales and is not likely to be a result of any particular scale factors.

Some may question whether what our participants have done could be called word learning. We believe it is and that the use of sound-symbolism could be one of the first steps in the search for word meaning. Many suggest that word learning occurs in increments (Shore & Durso, 1990). Sound-symbolism seems to provide a "hook" for word learners trying to ascertain the meaning of an unknown word in the absence of context.

We have attempted to rule out other less "semantic" reasons for our findings. One issue we addressed was the possibility that sound symbols do not carry meaning but that they merely serve to prompt word association emanating from initial word sounds, or a type of "sound association." To rule out this possibility separate analyses were done on all studies examining only generated definitions not containing the sound symbol present in targeted words. In all of these analyses the effect of sound-symbolism remained. This effect also remained in the recognition phases of Studies 2 and 3 when correct choices were designed not to contain sound associations. Thus, the effect of sound-symbolism cannot be dismissed as a result of simple sound association.

Related to the issue of sound association is the possibility that sound symbolism's benefits might emerge as a function of orthographic neighborhood effects. A neighborhood effect is any processing benefit or problem that might be caused from having words in the lexicon that share a large number of letters with the target word (Andrews, 1997). By definition, sound-symbolic words share letters with other words bearing the same meaning. Although the sound-symbolic words used in this study did not have any *a priori* neighbors because they were obsolete, participants may have been able to use their orthographic knowledge to guess at the word's neighborhood in the lexicon and may have based their guesses on lexical neighbors. We do not think that neighborhood effects could fully account for the sound-symbolism effect found in these studies. This orthographic mechanism was also available for all words in the study including the non-sound symbolic words. If neighborhood effects were responsible, then there would need to be an explanation for why participants knew to use these neighborhoods only for sound symbolic words. Further, responses based on the initial sounds of the word were removed from both word types and sound symbolic words were still guessed better.

An additional issue is whether sound-symbolism's effects on word learning are based on mediated priming. For example, perhaps the target word *scriek* may have primed the sound association word *scream,* which in turn may have primed the word *cry,* and the final response may have been the non-sound symbolic response of *cry.* Thus, even though we eliminated guesses based on sound association, it is possible that persons wrote down words based on mediated priming through these sound association words. It should be noted that in the "sound association" analyses in instances where multiple responses were generated, for example both *scream* and *cry* were written down, any one response containing the initial sound symbol of the target word lead to removal of that definition from the "sound association" analyses. It is possible, however, that the mediated prime was not written down and non-sound symbolic responses generated in this way would still have been included in the "sound association" analyses. As this mediated priming would have been more likely to result in a correct response for the sound symbolic words than for the non-sound symbolic words, the possible effect of indirect priming needs to be examined.

It is difficult to directly rule out this explanation for our effects. On logical grounds, it is hard to see why participants would have ever written down the indirect associations rather than the direct associations. Generally, mediated priming effects in other tasks such as word naming are small to nonexistent, rapidly disappearing, and easily interfered with (Farrar, Van Orden, & Hamouz, 2001; O'Seaghdha & Marin, 1997). Moreover, this mediated priming effect would be available for both sound-symbolic and non-sound symbolic words. If the sound-symbolism effect is not a true semantically based sound-symbolic process, we should see a similar willingness to guess based on mediated priming between the two word types. However, when we tabulated the number of participants' responses and non-responses we found that there was a greater number of non-responses for the non-sound symbolic than for the sound-symbolic words in Study 1 (sound-symbolic $M = 10.07$, non-sound symbolic

$M = 11.87$, $t(29) = 2.91$, $p < .05$), Study 2 (sound-symbolic $M = 16.45$, non-sound symbolic $M = 20.43$, $t(68) = 11.35$, $p < .01$) and Study 3 (sound-symbolic $M = 11.48$, non-sound symbolic $M = 13.69$, $t(138) = 8.30$, $p < .01$). Thus, subjects seemed to perceive that their guesses were better for sound-symbolic words than non-sound symbolic and were more willing to venture a guess for sound-symbolic words. Therefore, we feel that mediated priming, then, cannot account for the difference in participants' performance on the sound-symbolic words, as it was not a general strategy used equally by participants for both word types. For mediated priming to account for our findings there would have to be some explanation for why participants were more willing to formulate a guess as to the meaning of a sound symbolic word.

In this research, then, we have tried to control for all possible variables, except sound-symbolism, that could result in participants scoring higher on sound-symbolic words. Some of these controls were very conservative. For example, the Dale et al. (1986) knowledge level checklist, used to control for any possible prior word knowledge. For this control any word ranked by participants at a knowledge level of 2 or more and for which participants displayed knowledge in either the guess or recognition phases were eliminated from analyses. This strategy may have actually served to minimize the size of the sound symbolism effect. To investigate this we examined the number of sound-symbolic words removed from analyses based on this control. We found that in Study 2 the number of sound symbolic words removed (59%), based on the Dale et al. checklist, was significantly greater than the number of non-sound symbolic words removed, $\chi^2(1) = 9.24$, $p < .05$. We also found that in Study 3 the number of sound-symbolic words removed from analyses (59%) was significantly greater than the number of non-sound symbolic words removed, $\chi^2(1) = 10.06$, $p < .05$. It is unlikely that participants really did "know" the meanings of this many obsolete English words, and instead may have "felt" that they knew the meanings because of sound-symbolism itself. Despite this very conservative elimination of supposedly "known" items *a priori*, an effect of sound-symbolism was still found in both Study 2 and Study 3.

Having established that sound symbolism is a word feature that people can use for word learning, how big an effect this clue to word learning will have in the real world is of importance. Or more specifically, what portion of the English language is sound-symbolic? The answer to this second question has not been determined to date as there is no exhaustive list of English sound symbols. However, we attempted to estimate the importance of the effect for sound-symbolism in English, by surveying the 5,000 most frequent English words listed in Carroll, Davies, and Richman's *Word Frequency Book* (1971) for words containing the 13 initial sound symbols used in this research (words with the same morphological base were counted as a single word). Of these 5,000 most frequent words, 213 contained the 13 initial sound symbols used in this research, and 51 of these 213 words, or 24%, were sound-symbolic. Thus, for words containing these sound symbols, sound-symbolism could indeed be a key player in vocabulary growth. This is true especially when one considers that the number of possible meanings for an unknown word are almost infinite. Thus, any strategy that can help narrow down the possible meaning of a word is useful to word learners.

In this research we have discussed sound symbols as units of sound (phonemes) that carry meaning. Traditionally, however, morphemes have been considered the smallest units of language that carry meaning. For example, in the word "unwrap" both "un" and "wrap" would be considered morphemes because each part contributes distinct elements of meaning to the word. The question, then, is whether sound-symbolism is really a subset of phonology, morphology or something entirely different? This is a running question in the area of sound symbolism with advocates of all three positions. Most researchers examining assonance (initial consonants or consonant clusters) and rime (a vowel and the final consonants) have not called their analyses morphology, but instead have decided to use a distinctive term such as *phonestheme* (Bolinger, 1950). Others have suggested that these sounds that carry meaning are sub-morphemic (McCure, 1985). Still, others (Rhodes & Lawler, 1981) are of the opinion that assonance-rime is simply a case of derivational morphology.

Bolinger suggests that we cannot distinguish between a collection of phonemes which show little variation in meaning and those that vary extensively under different conditions, "we must either admit extensive homonymy or not consider them as morphemes at all, in the sense that a morpheme depends on consistency of meaning ... If we can show enough regularity in use, a rime or an assonance should be, or come very near to being, a morpheme." (p. 131). He then proceeded to examine words beginning with the [gl-] sound to demonstrate that only half of the English words containing the [gl-] sound have meanings corresponding to 'visual phenomena.' Bolinger concluded that "where such unrelated rimes and assonances occur, and intersect others that are related and meaningful, we have sub-morpheme differentials" (p. 133). Sound-symbolism, then, seems to be more than phonology, as it carries meaning, but less than morphology because the one-to-one relationship between sound and meaning is not as strong or as stable.

Whether sound symbols are processed and stored in the lexicon more like phonemes, morphemes or something separate is another question. Some have begun to examine how sound-symbolism influences lexical processing. Research has suggested that the presence of sound-symbolism speeds reaction times. Sereno (1994) examined the sound symbolic phenomenon that for high-frequency words nouns more often contain back vowels and verbs more often contain front vowels. Using 12 university students and 32 nouns and verbs of high and low frequency, Sereno found that for both high and low frequency words nouns that had back vowels were categorized faster than nouns that had front vowels and verbs that had front vowels were categorized faster than verbs that had back vowels. Thus, sound-symbolic information available in words seems to influence word processing. As this type of research has just begun to be examined, we are limited in the kinds of conclusions we can draw regarding the role that sound symbolism and its relationship to morphology might play in lexical processing. We believe that this question cannot be answered until we have not only examined how sound-symbolism effects lexical representations and processing more in depth, but have also come to a conclusion as to how morphology affects lexical representations and processing.

Lastly, the question of where sound-symbolism fits with other word properties is of concern. Most of the sound symbols that we have encountered in our research have referred to concrete referents. Thus, sound-symbolisms may lead to increased word learning as they not only provide a clue as to the meaning of a word but are also likely to signify a concrete referent. Sound symbols are also similar to morphemes in that they carry meaning, and allow for word learning in the absence of contextual information. Sound-symbolism, then, is a complex phenomenon encompassing many aspects of language; exactly how it fits into the structure of language is a question still to be answered. Regardless, the present studies provide clear evidence for the role of sound-symbolism as a piece in the puzzle of word learning. Based on these compelling results, sound-symbolism and its effect on word learning warrant further investigation.

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Appendix A

Definitions of sound symbolic stimuli	
clacker	a rattle
clammas	a loud noise
clicket	a clinking (jingling) noise
craske	to smash
crunkle	to squish
dreen	to remove all water
drook	to wet
flabellation	fanning
flam	a rough fall
flang	past of fling
flaucht	a flash of lightning
flob	to move in a clumsy or aimless way
flotte	to flow (cascade)
fluce	to flounce (bounce)
glede	a bright, burning coal
glimcy	smooth and shining, mirror like
glime	to shine brightly and steadfastly
glisk	to sparkle
grame	anger
greme	to bother
jactitate	to toss and turn
jow	the swing of a bell
scranch	to scratch (rub)
scriek	a cry or sound
scroop	to squeak
sleech	to dip out water
slive	to slip down (skid)
sloke	to cool with water
snaught	past of snatch
snite	to blow the nose
snoke	to pry into holes and corner, to poke one's nose where it has no business
snoove	to pry, to sneak, to creep
staffle	to walk around in a weird way
strake	to walk around
swaff	to come one over the other, like waves upon the shore
swaib	to move back and forth like a pendulum
swale	to distend and wave in the wind
sweg	to sway to and fro (wave back and forth)
traik	to wander without purpose
trig	to fall while walking
trimple	a wobbly walk
twage	to pinch; to squeeze
twight	to twitch (jerk)
twigle	to squirm

Note. Words in parentheses are synonyms for words used in the recognition phase choices of Studies 2 and 3

Appendix B

Definitions of non-sound symbolic stimuli	
aidle	to earn one's bread indifferently well
bauch	indifferent, insipid
bole	the trunk of a tree
bourd	a joke
busk	to get ready
choile	to overreach
ettle	to try
etyn	a giant
fay	to clean up
fete	work
fud	a tail
goffram	a clown
gome	a man
hend	gentle
hent	to hold, to seize
henter	a thief
jimp	dainty, well formed, well fitting
kep	to catch, to receive
kexy	dry
kith	to show, to appear
lea	a field
leuch	past of laugh
mammer	to hesitate, to doubt
maups	a silly girl
meare	a boundary
meazy	dizzy (wobbly)
nantle	to fondle, to caress
nare	a nose
naye	an egg
nesp	to bite
rax	to reach
reave	to take away
rede	to advise, to council
targe	a shield
tarne	a girl
tasse	a cup
teld	to build, to erect
queme	to please
umgripe	to catch
unco	strange
vade	to fade quickly, to go to death or decay
welkin	the sky
weth	soft
wode	mad, furious, wild
wox	to grow

References

Andrews, S. (1997). The effect of orthographic similarity on lexical retrieval: Resolving neighborhood conflicts. *Psychometric Bulletin & Review, 4*, 439–461.

Benson, J., & Nasser, F. (1998). On the use of factor analysis as a research tool. *Journal of Vocational Education Research, 23*, 13–33.

Bloomfield, L. (1933). *Language*. New York: Holt, Rinehart and Winston.

Bolinger, D. (1950). Rime, assonance, and morpheme analysis. *Word, 6*, 117–136.

Brennan, R. L. (1992). *Elements of generalizabilty theory.* Iowa City: ACT Publications.

Brown, R. W. (1958). *Words and things.* Glencoe, IL: The Free Press.

Brown, R. W., Black, A. H., & Horowitz, A. E. (1955). Phonetic symbolism in natural languages. *Journal of Abnormal and Social Psychology, 50*, 388–393.

Carroll, J. B., Davies, P., & Richman, B. (1971). *Word frequency book.* New York: American Heritage Publishing Co., Inc.

Cassidy, K. W., Kelly, M. H., & Sharoni, L. J. (1999). Inferring gender from name phonology. *Journal of Experimental Psychology: General, 128*, 362–381.

Cassidy, K. W., & Kelly, M. H. (2001). Children's use of phonology to infer grammatical class in vocabulary learning. *Psychonomic Bulletin and Review Journal, 8*, 519–523.

Choi, S., & Gopnik, A. (1995). Early acquisition of verbs in Korean: A cross-linguistic study. *Journal of Child Language, 22*, 497–529.

Ciccotosto, N. (1991). Sound symbolism in natural language (Doctoral dissertation, University of Florida, 1991) *Dissertation Abstracts International, 53*, 541.

Cohen, J. (1968). Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit. *Psychological Bulletin, 70*, 213–220.

Crick, J. E., & Brennan, R. L. (1984) GENOVA A general purpose analysis of variance system [Computer software and manual].

Dale, E., O'Rourke, J., & Barbe, W. B. (1986). *Vocabulary building: A process approach*. Columbus, OH: Zaner-Bloser.

Durso, F. T., & Shore, W. J. (1991). Partial knowledge of word meanings. *Journal of Experimental Psychology: General, 120*, 190–202.

Ervin, S. M. (1961). Changes with age in the verbal determinants of word-association. *American Journal of Psychology, 74*, 361–372.

Farrar, W. T., Van Order, G. C., & Harmouz, V. (2001). When SOFA primes TOUCH: Interdependence of spelling sound and meaning in "semantically mediated" phonological priming. *Memory & Cognition, 29*, 530–539.

Grambs, D. (1994). *The endangered English dicitonary*. New York: W.W. Norton & Company.

Halliwell, J. O. (1850). *A dictionary of archaic and provincial words, obsolete phrases, proverbs, and ancient customs*. London: John Russell Smith

Hinton, L., Nichols, J., & Ohala, J. J. (1994). *Sound symbolism.* New York: Cambridge University Press.

Kelly, M. H. (1992). Using sound to solve syntactic problems: The role of phonology in grammatical category assignments. *Psychological Review, 99*, 349–364.

Kess, J. F. (1992). *Psycholinguistics: Psychology, linguistics, and the study of natural language*. Victoria, Canada: John Benjamin Publishing Company.

Laird, C. G., & Agnes, M. (1999). *Webster's New World Roget's A–Z thesaurus*. New York: Macmillan USA.

LeCron Foster, M. (1978). The symbolic structure of primordial language. In S. L. Washburn & E. R. McCown (Eds.), *Human evolution biosocial perspectives* (pp. 77–122). Merlo Park, California: The Benjamin/Cummings Publishing Company.

MacKay, C. (1879). *The lost beauties of the English language.* London: Chatton & Windus.

Malkiel, Y. (1990). *Diachronic problems in phonosymbolism.* Philadelphia: J. Benjamin Publishing Company.

Markel, N. N., & Hamp, E. (1960). Connective meanings of certain phoneme sequences. *Studies in Linguistics, 15*, 41–61.

McCure, K. (1985). *The internal structure of Indonesian roots.* Badan Penyelenggara Seri Nusa, Universitas Katolik Indonesia Atma Jaya.

Nagy, W. E., Anderson, R. C., & Herman, P. A. (1987). Learning word meanings from context during normal reading. *American Educational Research Journal, 24*, 12.

Nagy, W. E., Herman, P. A., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly, 20*, 233–253.

Nuckolls, J. B. (1999). The case for sound symbolism. *Annual Review of Anthropology, 28*, 225–252.

O'Seaghdha, P. G., & Marin, J. W. (1997). Mediated semantic–phonological priming: Calling distant relatives. *Journal of Memory & Language, 36*, 226–252.

Rhodes, R. A., & Lawler, J. M. (1981). Athematic metaphors. *Chicago Linguistic Society, 17*, 318–342.

Sapir, E. (1929). A study in phonetic symbolism. *Journal of Experimental Psychology, 12*, 225–239.

Saussure, F. D. (1959). *Course in general linguistics*. New York: Philosophical Library.

Schwanenflugel, P. J. (1991). Why are abstract concepts hard to understand? In P. J. Schwanenflugel (Ed.), *The psychology of word meaning* (pp. 223–250). Hillsdale, NJ: Lawrence Erlbaum Associates.

Schwanenflugel, P. J., Stahl, S. A., & McFalls, E. L. (1997). Partial word knowledge and vocabulary growth during reading comprehension. *Journal of Literacy Research, 29*, 531–553.

Sereno, J. A. (1994). Phonosyntactics. In L. Hinton, J. Nichols, & J. J. Ohala (Ed.), *Sound Symbolism* (pp. 263–275). New York: Cambridge University Press.

Shore, W. J., & Durso, F. T. (1990). Partial knowledge in vocabulary acquisition: General constraints and specific detail. *Journal of Educational Psychology, 82*, 315–318.