Relative Frequency and Semantic Relations as Organizing Principles for the Psychological Reality of Phonaesthemes

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The perception of Swedish phonaesthemes and their psychological reality is studied in priming and lexical decision experiments. Abelin (1999) described phonaesthemes such as: bl- 'light, vision' in words like 'blänka, blixtra' and fl- 'movement' in words like 'fladdra, flaxa'. Bergen (2004) studied phonaesthemes like: gl- 'light, vision' in words like 'glimmer, glisten' and sn- 'nose, mouth' as in 'snore, snout'. The first hypothesis is that if the presence of phonaesthemes affects processing, then primed responses should be faster than unprimed (i.e. in lexical decision) responses. The second hypothesis is that the degree of facilitation from priming for indivual phonaesthemes will correlate with relative lexical frequency. The method used is a comparison between priming tasks and lexical decision tasks. Three experiments were run, with the same design but partly different phonaesthemes. The results show that phonaesthemic priming affects processing and that there are clear differences between different phonaesthemes when combining related meanings; there is a positive correlation between high relative lexical frequency of phonaesthemic clusters and increase of speed in priming condition. The results are compatible with an embodied usage based perspective on language and language acquisition.

Keywords: phonaestheme, sound symbolism, frequency, priming, embodiment

1. Introduction

The purpose of this paper is to describe the perception of phonaesthemes in priming and lexical decision experiments. Abelin (1999) described phonaesthemes such as: bl- 'light, vision' in words like *blänka, blixtra* and fl- 'movement' in words like *fladdra, flaxa*. Bergen (2004) studied phonaesthemes like: gl- in 'light, vision' in words like *glimmer, glisten* and sn- 'nose, mouth' as in *snore, snout*. Phonaesthemes constitute a statistically significant subpart of the lexicon and fall into the more general area of sound symbolism. They show distributional evidence and they can also be shown to play a role in language change; they form part of the generation of neologisms, and are used in poetry, child language and general language. New, sometimes short-lived, words are created, at a slow pace, and they are understood. Sound symbolism has attracted increasing interest in recent years, especially in relation to language learning and language evolution, cf. e.g. MacWhinney (2005), who mentions it as one aspect of resonance, which aids language learning, and Namy and Nygaard (2008), who propose that evidence for perceptual-motor grounding of language comes from non-arbitrary sound-to-meaning correspondences and their role in word learning. Nygaard et al. (2009) showed that sound symbolism can facilitate word learning in a foreign language, Kovic et al. (2010), studied the relationship between sound symbolic label–object associations and found behavioural and neuropsychological evidence for the psychological reality of sound symbolism. Parault and Parkinson (2008) concluded that sound symbolism is a word property which influences the learning of unknown words. Farmer et al. (2006) showed a probabilistic relationship between the sound of a word and its lexical category, i. e. for verbs and nouns. They concluded that "although the sound of a word may not provide cues to its specific meaning, phonological typicality, the degree to which the sound properties of an individual word are typical of other words in its lexical category, affects both word- and sentence-level language processing" (p. 12203). Maurer et al. (2006) concluded that naturally biased correspondences between sound and shape may influence the development of language. Wichmann et al. (2010) studied basic vocabulary in nearly half of the world's languages and found commonalities among sound shapes for words referring to the same concepts. They claim that studying the effects of sound symbolism cross-linguistically is of key importance for the understanding of language evolution. Ramachandran and Hubbard (2001) discuss a possible explanation for the origin of proto-language in terms of natural constraints on the ways in which sounds are mapped on to objects, a kind of sensory-to-motor synaesthesia with a possible link to mirror neurons. Ohala's (1994) theory of the frequency code has demonstrated that there can be an auditive-acoustic connection between e.g. sound and size. Kawahara et al. (2008) have pointed out the prominence of word initial information. Research on sound symbolism typically discusses the questions of probabilistic sound-meaning relationships vs. sound-meaning relationships founded in embodied cognition and related to mirror neurons. Another issue is the question of innateness vs. learning in an environment.

Abelin (1999) found that listeners understand phonaesthemic neologisms and that they produce neologisms along the lines of phonaesthemes. If phonaesthemes also show priming effects in real time experiments, this will indicate that phonaesthemes are part of the subconscious language competence. The present article describes three experiments where native speakers of Swedish performed priming and lexical decision tasks. The experiments were partly modelled on the design in Bergen (2004), in order to be able to make direct comparisons with Bergen's results on phonaesthemes and to be able to make comparisons between English and Swedish. The phonaesthemes tested were the ones that were the most frequent, either absolutely or percentually, in Abelin (1999). (Absolute frequency is defined here as the number of sound symbolic root morphemes of a certain initial consonant cluster, and relative or percentual frequency as the number of sound symbolic root morphemes of a certain consonant cluster in relation to the total number of root morphemes that begin with that consonant cluster).

The lexical analysis in Abelin (1999) showed that some consonant clusters carried more of a certain meaning or meanings than others, either in absolute numbers (e.g. sl- having more than 80 root morphemes that were potentially motivated, most of them being pejorative or having to do with wetness), or in percent (e.g. fn- having 100% root morphemes that are pejorative – but only a total of 10 root morphemes). The productivity of some of the potentially sound symbolic clusters was tested in Abelin (1999), and the purpose now is to test them in real time priming experiments. For both the interpretation and production tests, the most successful cases in Abelin (1999) were 'dryness': fn- and 'pejorative': pj-. Both of these are lexically low frequency clusters in absolute numbers, but percentually high frequent.

1.2 Hypotheses

The first hypothesis was that if the presence of phonaesthemes affects processing, then primed responses should be faster than unprimed (i.e. in lexical decision) responses. The second hypothesis was that the degree of facilitation from priming for individual phonaesthemes will correlate to relative lexical frequency.

2. Background

2.1 What are Phonaesthemes?

Phonaesthemes are a special case of sound symbolism. Some examples are: *gl-* 'light, vision' as in English *glimmer*, *glisten*, *glitter*, *gleam*, *glow*, *glint, sn-* as in 'nose, mouth' *snore*, *snack*, *snout*, *snarl*, *snort*, *sniff*, *sneeze*, *fj-* 'pejorative' as in Swedish *fjant, fjollig, fjompig, fjuttig, fjäska*, *sl-*'wetness' as in Swedish *slask, slem, slam*, *fl-* 'movement' as in Swedish *flacka, fladdra, flagga, flamma, flaxa, flimra, fläkta, flämta, flänga*, or English *flutter*, *flag*, *kn-* 'sound' as in Swedish *knacka, knaka, knall, knarra, knastra, knattra, knirra, knorra, knäppa* (Abelin 1999; Bergen 2004).

Some early definitions of "phonaestheme" are: the grouping of similar meanings about similar sound (Bolinger, 1965), a phoneme or cluster of phonemes shared by a group of words which also have in common some element of meaning or function, though the words may be etymologically unrelated (Householder, 1946), collocations of phonemes common to a set of words and suggestive of a stronger or vaguer semantic interconnection (Bolinger, 1950), frequently recurring sound-meaning pairings that are not clearly contrastive morphemes (Firth, 1930).

Phonaesthemes can be involved in the invention of new words. They can be detected through their roles in language change, especially by the part they play in the generation of neologisms, that is newly-invented words. "Bling-bling" is hip hop slang for jewellery and other striking accessories. The origin of the word is said to be the imaginary sound when light hits a diamond. "Bling" is also a loan word in Swedish which fits into the Swedish pattern of light imagery, cf. *blank* (glossy), *blek* (pale), *blinka* (blink), *blixt* (lightning), *blond* (blond), *blossa* (blaze), *blänka* (glisten). (The alternations between bl- an gl- for 'light' words is also interesting from an acoustic-perceptual phonetic point of view, since [b] and [g] have similar acoustical properties, in contrast with [d].) There is also the newly-created verb "blinga" (to bling). Other examples in Swedish are “blippa” (to scan with a barcode scanner, e.g. goods and credit cards – imitative of sound and light), “Dongel”, “dongla” (dongle) an example of a word ending –“ngla” (as in Swedish *dingla*, *vingla*, *ringla*, *singla*, *mingla*) denoting movement back and forth. Yet another example might be “tvittra”, from “twitter” leading the association to “kvittra” (chirp, twitter – of birds). Amusing examples are the Hogwart personalities in the Harry Potter books: Hufflepuff – the loyal badger, Gryffindor – the brave lion, Slytherin – the cunning snake and Ravenclaw – the intelligent eagle. The question is whether a brave lion would ever be called Hufflepuff? Probably not.

There are many more examples of new sound symbolic coinages in literature, e.g in *Gulliver’s Travels* (e.g the names Brobdingnag, Lilliput) and *Alice in Wonderland* (e.g. the Jabberwocky). We find sound symbolic neologisms in poetry, in child language and in general language, where they are sometimes short-lived.

It can be stated that neologisms are created, usually at a slow pace, and that they are understood. One way to study neologisms is to study them in interpretation and production experiments.

2.2 Previous Interpretation and Production Experiments in Swedish

In Abelin (1999) the hypothesis was formulated that phonaesthemes are productive, to a greater or lesser extent. In order to test this hypothesis several experiments were carried out. The purpose of the experiments was to test the hypothesis of productivity, and this was done in more detail for some of the phonaesthemes. The results of the lexical analysis were preliminary and were used as a basis for testing the sound symbolic value of certain consonant clusters on a large number of individuals.

The tests had one of the three following structures:

- What is the meaning of the sound sequence x?
- Invent a word for meaning y.
- Match sound sequence x with meaning y.

The results of the interpretation and production experiments in Swedish (Abelin, 1999) were, in short, that language users do understand phonaesthemic neologisms and that they produce neologisms along the lines of phonaesthemes.

Most of the phonaesthemes were successfully interpreted or coded, while some were quite clearly not interpreted or coded. The most successful phonaestheme was ‘pejorative’: pj- and the least successful was ‘light’: gn- and ‘winding form’ (kr-). Pj- and gn- are low frequency in absolute numbers but high frequency percentually.

The clusters of most of the most successful phonaesthemes – fj-, fn-, vr-, pj-, spr-, skr- and mj- – are low frequency in absolute numbers, but very sound symbolic percentually. Str-, sp-, gr-, sn- and sk- are not percentually high frequency. Of the least successful phonaesthemes, gn- is lexically not very frequent in absolute numbers, but it is percentually frequent, and gl- is quite frequent percentually. The "light" clusters gl- and gn- did not seem to be productive (Abelin, 1999).

The ten Swedish initial clusters with the highest number of sound symbolic words are, in order of descending frequency: sl-, sn-, kn-, kr-, kl-, sp-, st-, gl-, tr- and fl-. The ten Swedish initial clusters with the percentually highest proportion of sound symbolic words are, in order of descending frequency: fn-, gn-, skv-, pj-, kn-, spr-, spj-, gl-, mj- and vr- (Abelin, 1999).

From the previous experiments I concluded that phonaesthemes show productivity; new words are created from phonaesthemes and phonaesthemes are involved in the creation and the understanding of new words. There is also an indication of varying degrees of productivity in phonaesthemes.

The question posed for this study was: to what extent do phonaesthemes play a role in the synchronic mental organization of language? This was tested in real time priming experiments and a comparison with the study by Bergen (2004) will be made.

3. Method

The method used is a comparison between priming tasks and lexical decision tasks. In the priming experiment language users are presented with a sequential pair of words. It produces a processing advantage for the second word (a facilitatory priming effect) if the words have some similarity (semantic, phonological, morphological, etc). In the present experiments the question is whether words with phoneasthemes give a priming effect in Swedish, e. g. if *flaxa* (flap) will produce a facilitatory priming effect in *fladdra* (flutter).

Morphological priming effects have been shown to be faster than only semantic or only phonological priming. This has been an argument for the psychological reality of morphemes. In the study by Bergen (2004) phonaesthemic priming was shown to be significantly faster than only phonological priming or semantic priming – and thus phonaesthemes seem to have morpheme status in English. In Bergen's experiments, phonaesthemes, despite being noncompositional in nature, displayed priming effects much like those that have been reported for compositional morphemes. Furthermore, only form was slower and only meaning was slower. Bergen tested the word initial phonaesthemes gl- and sn-/sm-.

3.1 Material

The stimuli classes in the present experiments were:

1. The condition ‘phonaestheme’, meaning that the prime and the target words share a semantic feature and phonological onset cluster **and** that they are a statistically significant subclass in the lexicon, e.g. *flaxa* – *fladdra* (flap – flutter)

2. The condition ‘baseline’, which means that prime and target are unrelated both in form and meaning, e.g. *lada* – *rysch* (barn – frill). The baseline words are not only unrelated, they are also arbitrary (not sound symbolic) words. Baseline should not give priming effects.

3. The target words of the priming test were also tested in isolation, in ordinary lexical decision experiments, in order to check the effect of priming in comparison with no priming. (There are no ready-made Reaction Time lists for Swedish, as there are for English, for example the Oxford Psycholinguistic database, English Lexicon project).

3.2 Participants and Procedure

3.2.1 Experiment 1

– 11+8 native speakers of Swedish (female, ages 20–25). Eleven speakers did the lexical decision task with priming and 8 speakers did the lexical decision task without priming.
– Prime stimuli appeared slightly above the center of the screen for 150 msec.
– Target stimuli appeared 300 msec later, for 1000 msec or until the subject responded to them.
– Stimuli words: phonaesthemically related words, and baseline (unrelated words) 15+10.
– Each cluster occurred 2-3 times.
– Nonwords 25.
– Subjects performed lexical decision tasks – one group with priming and one group without priming.
– The phonaesthemes tested were sl- (wetness), fl- (movement), kn- (onomatopoeic), gl- (light), sp- (thin form) and spj- (thin form).

3.2.2 Experiment 2

– 20+21 native speakers of Swedish (female, ages 20–30).
– Prime stimuli appeared slightly above the center of the screen for 150 msec.
– Target stimuli appeared 300 msec later, for 1000 msec or until the subject responded to them.
– Stimuli words: phonaesthemically related words, and baseline (unrelated words) 15+10.
– Each cluster occurred 2-3 times.
– Nonwords 25.
– Subjects performed lexical decision tasks – one group with priming and one group without priming.
– The phonaesthemes tested were the same as in Experiment 1: sl- (wetness), fl- (movement), kn- (onomatopoeic), gl- (light), sp- (thin form) and spj- (thin form).

3.2.3 Experiment 3

- 7 (x 2) native speakers of Swedish (female, ages 25–40) who performed 2 lexical decision tasks – one with priming and one without priming, with two weeks between the tests. (The subjects did the priming task first and the lexical decision task afterwards in order to not have undesirable effects which might have been suspected if the priming task had been done after the lexical decision task.)
- Prime stimuli appeared slightly above the center of the screen for 150 msec.
- Target stimuli appeared 300 msec later, for 1000 msec or until the subject responded to them.
- Each cluster occurred 2-3 times.
- Stimuli words: phonaesthemically related words, and baseline (unrelated words) 21+13.
- Nonwords 34.
- The phonaesthemes tested were fn- (dryness), gn- (talking), skv- (wetness), pj- (pejorative), kn- (with another meaning than in experiment 1 and 2 (round form), spr- (separation), sn- (talking), fj- (pejorative) and gr- (round form).

In all experiments the subjects were asked to decide as quickly and as accurately as possible, whether or not the target word was a real Swedish word. They responded by pressing one of two keys on the keyboard of a MacBookPro. The reaction time program PsyScope X (version B51) was used for the experiment. All subjects were tested in the same quiet room.

The first two experiments were carried out in order to explore the priming effects of different phonaesthemic consonant clusters with different absolute and relative frequencies. The third experiment was carried out in order to study the percentually highest frequency phonaesthemes that were also the most successful in the experiments of Abelin (1999), and in order to study the effects of using the same subjects in both the priming experiment and the lexical decision experiment in isolation.

4. Results

4.1 Results of Experiment 1

The main result from the first experiment was that phonaesthemic words are primed. The degree of facilitation in priming of phonaesthemes found was the same as in Bergen (2004), i. e. 5.9% faster, see Table 1. For both priming and lexical decision in isolation the Swedish subjects were 9.3% slower. This shows consistency in the results. The differences in numbers could be attributable to frequency effects rather than being an effect of differences between the Swedish and English languages.

One unexpected side effect was that the priming facilitated for both phonaesthemes and baseline words. Non-phonaesthemic (baseline) words were generally faster, both primed and in isolation. Faster responses in baseline conditions may indicate a frequency effect or post-lexical processing for the phonaesthemic words. In Abelin (1996), too, there were slower reaction times for phonaesthemes than for arbitrary words.) Although the higher degree of priming in base line condition is difficult to account for, it does not present a problem in terms of the general results.

	Bergen	Abelin	difference
Average RT priming	607	669	62 (9.3%)
Average RT isolation	645	711	66 (9.3%)
difference	38 (5.9%)	42 (5.9%)	

Table 1. The main result is the equal priming effects of phonaesthemic words. A paired t-test reveals that the difference between isolated phonaesthemes and primed phonaesthemes is significant ($p = 0.027$).

The conclusion from experiment 1 is that there seems to be the same priming effect for phonaesthemes in English and Swedish.

4.1.1 Errors

It is also interesting to look at the words where the subjects were too slow in responding or where they made mistakes, i.e. pressed the no button for a real sound symbolic word. These are the errors “no answer” or ”wrong answer”. Some of the words, especially “slafs” (sloppiness) and “slisk” (mush) had large error rates, or the subjects were simply too slow in reacting to these words.

In isolation:	
–No. 8 50%	*slafs (no. “1”)*
–No. 1363%	*slisk (no. “4”)*
In priming:	
–No. 8 18%	*slafs* after *slabb*
–No. 1327%	*slisk* after *slam*

Table 2. No answers or wrong answers. The error rates decreased in priming condition for some words.

Correct recognition of these words improved substantially with the priming condition. The word “slafs” improved from 50% rejection to only 18% rejection and the word “slisk” improved from 63% rejection to only 27% rejection. Language users seem to be uncertain as to whether or not some sound symbolic words are real words. With the priming condition the users became much more certain, i.e. they had activated the relevant phonaestheme.

4.2 Experiment 2

4.2.1 Method

In the second experiment the stimuli lists were changed in order to eliminate undesirable priming effects, especially in baseline condition. They were changed so as not to contain only verbs, not only have two syllable words and not only accent II words. Both primes and targets were changed slightly, while the phonaesthemes tested were the same. The procedure was the same as in experiment 1 but with 20 subjects in the priming condition and 21 subjects in the isolated condition.

4.2.2 Results of Experiment 2

The difference between primed and non-primed in baseline was less. The difference between primed and non-primed in phonaestheme was greater. Overall, reactions times were slower than in Experiment 1. The mean difference between unprimed and primed phonaesthemes was 717 – 693 = 24 or 3.35%.

4.2.3 Detailed Analysis of the Results of Experiment 2

The following question was considered in the detailed analysis made on the outcome of Experiment 2: Are there gradual differences between different phonaesthemes, rather than an all-or-none division between phonaesthemic and arbitrary words and pseudo-phonaesthemes? Two analyses were made: 1. analysis of phonaestheme facilitation in priming in the experiment (e.g. sl- "wetness") in relation to the percentual distribution of this meaning in the lexical analysis and 2. analysis of phonaesthemes' facilitation in priming in the experiment (e.g. sl- "wetness") in relation to the percentual distribution of ALL sound symbolic meanings for this cluster in the lexical analysis (e.g. sl- "wetness", "smooth surface", "quick movement", etc).

The 15 phonaesthemic word pairs in experiment 2 were:

8. slabb-slafs (wetness)
10. spjäla-spjut (thin form)
11. knirka-knacka (onomatopoeic)
13. slam-slisk (wetness)
19. spik-spets (thin form)
24. flämta-flaxa (movement)
25. slem-slask (wetness)
28. fläkta-flimra (movement)
32. knastra-knorra (onomatopoeic)
34. fladdra-flänga (movement)
42. knarra-knäppa (onomatopoeic)
44. knaka-knattra (onomatopoeic)
45. glittra-glöda (light)
51. spett-spira (thin form)
53. glänsa-glimma (light)

The phonaesthemes analyzed were thus sl- (wetness), fl- (movement), kn- (onomatopoeic), gl- (light), sp- (thin form) and spj- (thin form).

An analysis was made of the target words of different phonaesthemes in primed and unprimed condition. The mean differences between primed and unprimed phonaesthemes are shown in Figure 1. The Figure shows the correlations between mean priming facilitation, and absolute and relative frequency (for a certain meaning) of the 6 phonaesthemes.

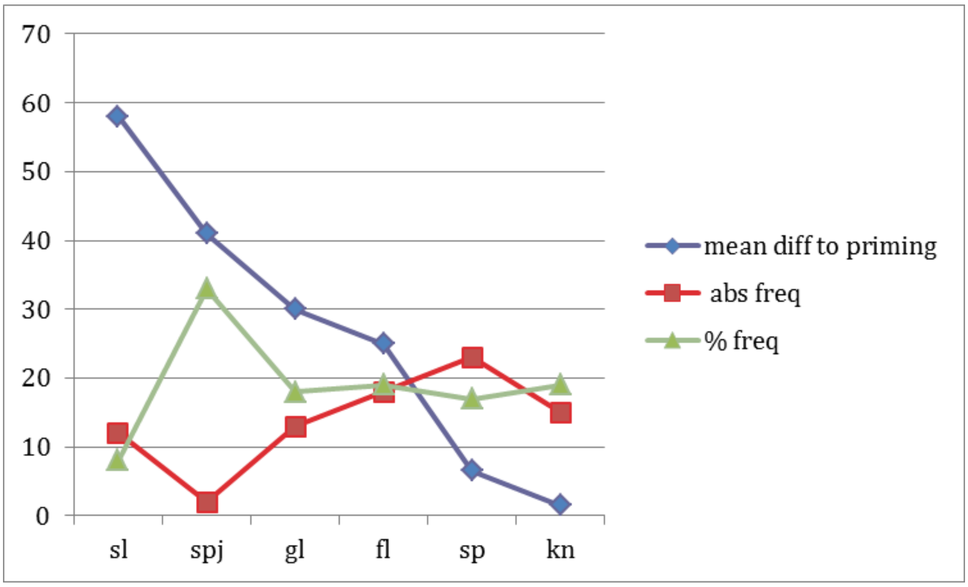

Figure 1. Mean priming facilitation, absolute lexical frequency and relative lexical frequency, for 6 phonaesthemes, ordered in relation to decreasing mean priming facilitation.

There is a slight negative correlation between absolute lexical frequency of phonaesthemes (for a certain meaning) and the mean priming effect. There is no correlation between relative lexical frequency (for a certain meaning) and mean priming speed.

Since the meaning categories for each cluster (e.g. sl-) are often connected, and have more or less clear boundaries, a comparison was made between mean priming time and frequencies for all sound symbolic words, independent of meaning, for each cluster (see Figure 2), (e.g. sl–has the meanings “wetness”, “onomatopoeic”, “pejorative”, “quick movement”, etc). Grouping together all sound symbolic meanings of a cluster yields different results, than the results shown in Figure 1.

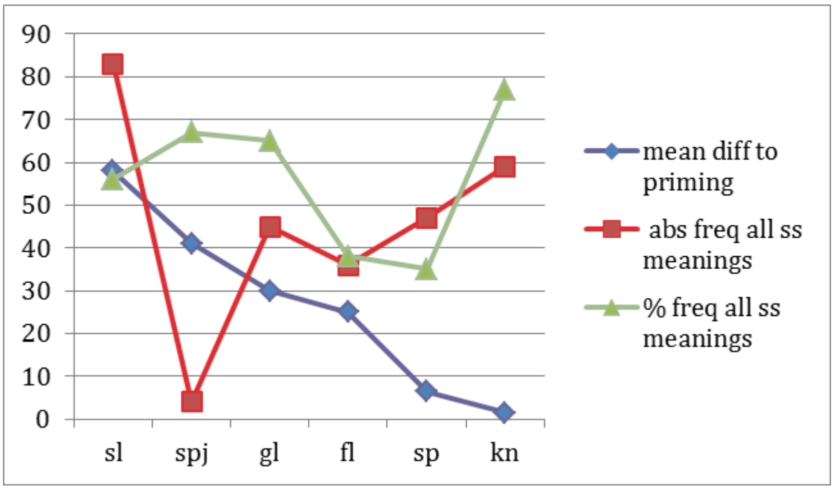

Figure 2. Mean priming facilitation, absolute lexical frequency and relative lexical frequency, for 6 phonaesthemes, ordered in relation to mean priming facilitation. All sound symbolic meanings of a cluster. Second experiment.

With the exception of the kn- cluster, there could be a correlation between mean priming time and the percentage of sound symbolic words (all sound symbolic meanings) of a certain cluster.

This is seen more clearly in Figure 3, arranged by falling absolute frequency.

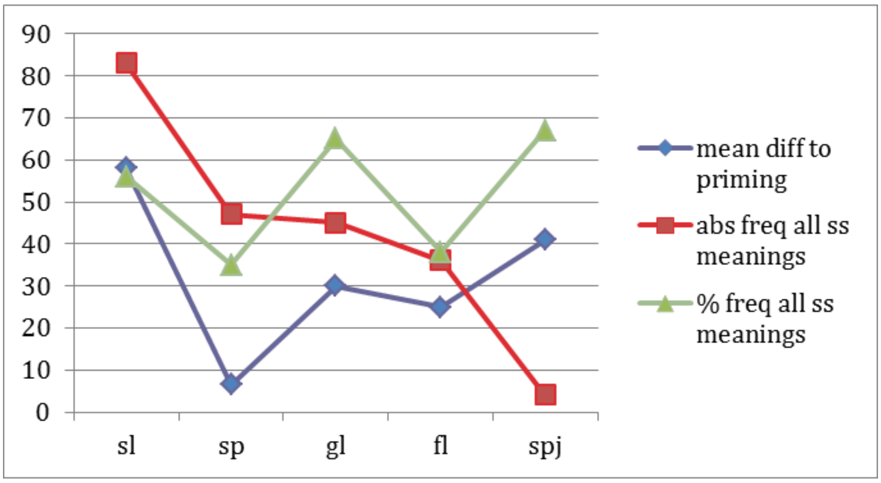

Figure 3. Percentual frequency of all sound symbolic meanings for a cluster in relation to mean priming facilitation, shown in relation to falling absolute frequency. The cluster kn- has been excluded. Second experiment.

The conclusion is that the higher the relative frequency of sound symbolic words (all sound symbolic meanings) a cluster has, the more facilitation there is in priming, i.e. the more sound symbolic the cluster is. Thus, the question is not whether or not clusters are phonaesthemic. Instead, the clusters have a gradual phonaesthemic status. This was explored further in experiment 3, with different phonaesthemes than in experiments 1 and 2.

4.3 Experiment 3

The third experiment focused on the percentually most frequent phonaesthemes according to Abelin (1999: 87).

These are:

fn- (10 out of 10 root morphemes are sound symbolic, 100%)
gn- (20 out of 22 root morphemes are sound symbolic, 91%)
skv- (9 out of 10 root morphemes are sound symbolic, 90%)
pj- (6 out of 7 root morphemes are sound symbolic, 86%)
kn- (59 out of 77 root morphemes are sound symbolic, 77%) (also tested in experiments 1 and 2)
spr- (23 out of 34 root morphemes are sound symbolic, 68%)
sn- (62 out of 126 root morphemes are sound symbolic, 49%)
fj- (7 out of 24 root morphemes are sound symbolic, 29%)
gr-[i] (26 out of 126 root morphemes are sound symbolic, 21%)

The last three were included since they had been shown to be very productive in Abelin (1999).

The 9 clusters tested in experiment 3 are thus: fn- (dryness), gn- (talking), skv- (wetness), pj- (pejorative), kn- (with a different meaning than in experiments 1 and 2 (round form), spr- (separation), sn- (talking), fj- (pejorative) and gr- (round form).

4.3.1 Results of Experiment 3

The results were in accordance with the hypotheses: clusters with a percentually high proportion of sound symbolic words are facilitated more in the priming condition and show greater differences in reaction times. There is a correlation between increase in priming facilitation and percentual frequency of phonaesthemes, see Figure 4.

The data from experiment 3 are compared with the data from experiment 2, in Figures 5a and 5b. All clusters: five clusters in experiment 2 and nine clusters in experiment 3, were different. All these 14 clusters from the two experiments show a correlation between relative frequency of all sound symbolic meanings for a cluster and mean priming facilitation, i.e. the more sound symbolic a cluster is the faster the reaction time is in priming.

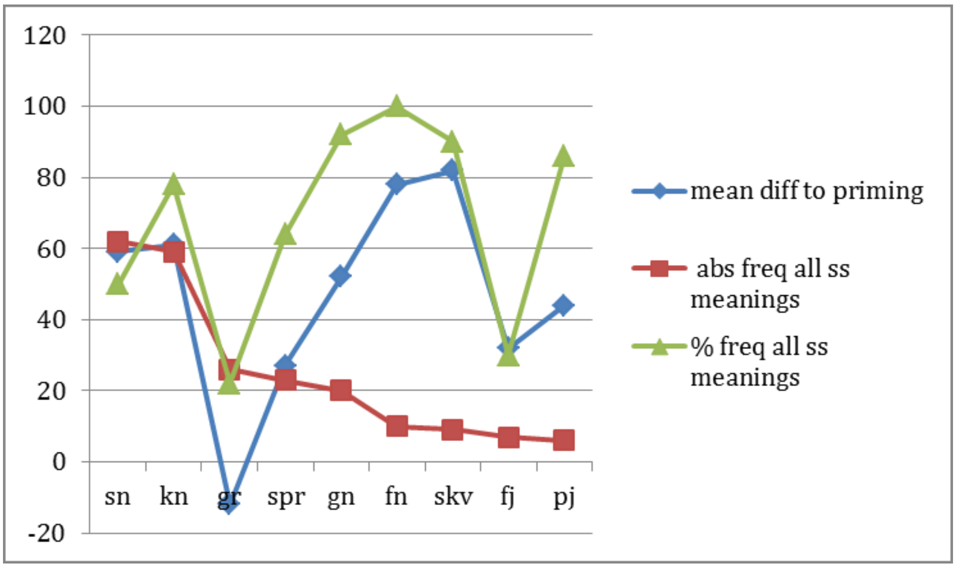

Figure 4. Percentual frequency of all sound symbolic meanings for a cluster in relation to mean priming facilitation, shown in relation to falling absolute frequency. Third experiment.

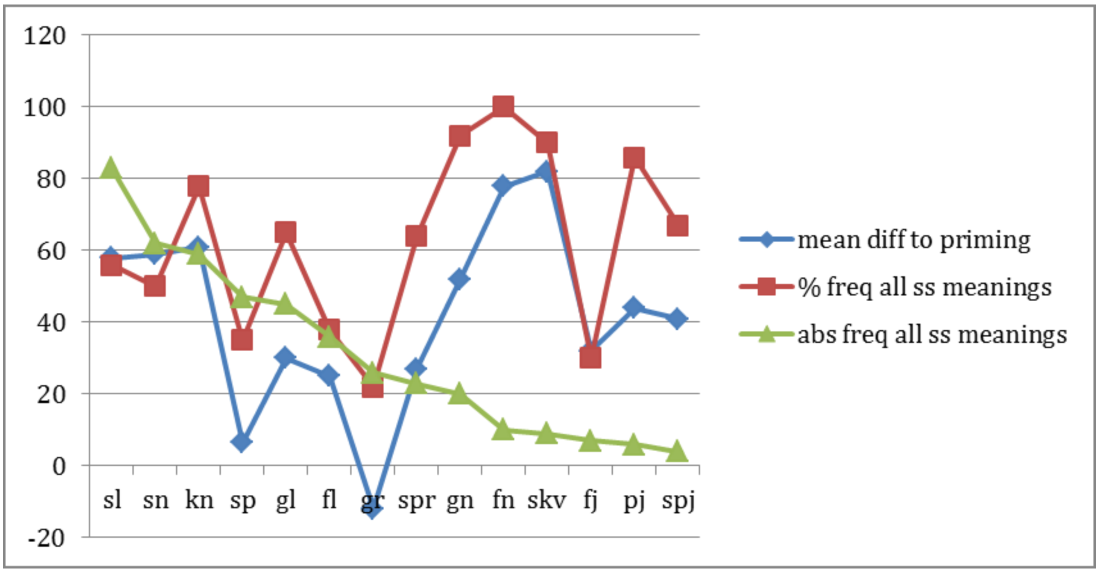

Figure 5a. Percentual frequency of all sound symbolic meanings for a cluster in relation to mean priming facilitation, shown in relation to falling absolute frequency. Second and third experiments.

The linear regression is shown in Figure 5b.

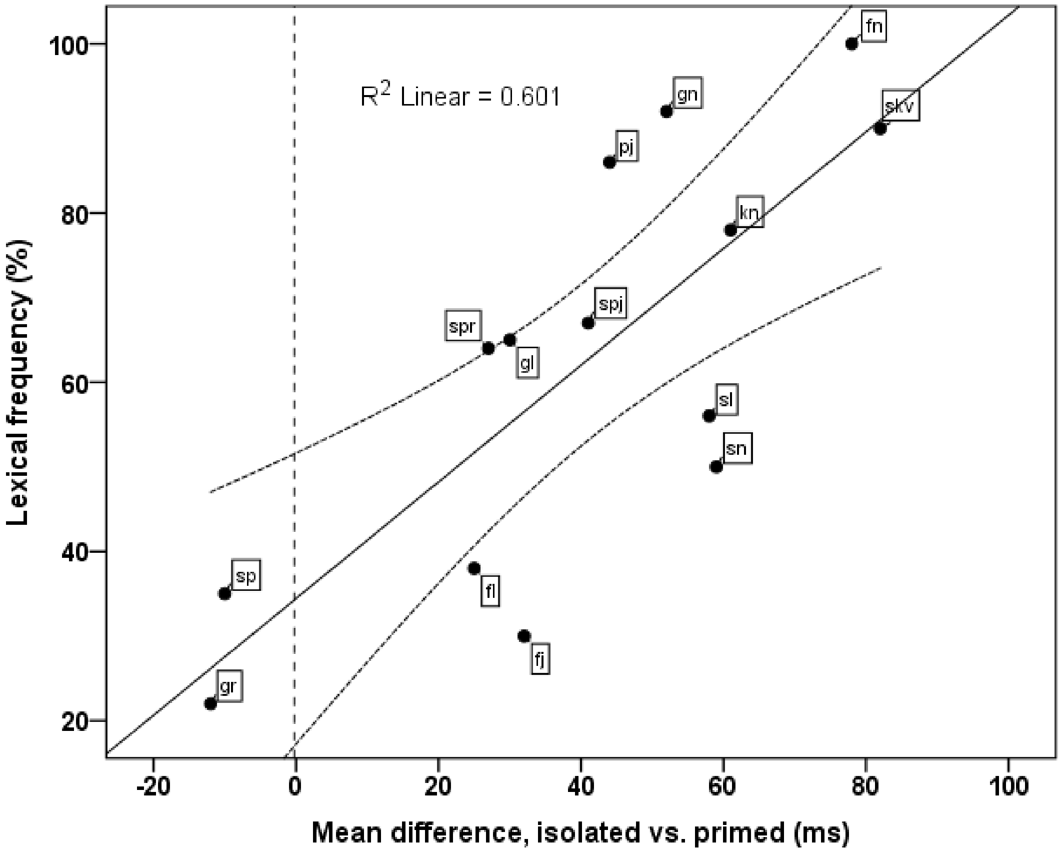

Figure 5b. Results from experiments 2 and 3. Priming facilitation correlated with percentage frequency and shows a linear regression of 0.601. (R^2 Linear = 0.601). The prediction is that all phonaesthemic clusters will follow the same tendency. The order of clusters is gr, sp, fl, spr, gl, fj, spj, pj, gn, sl, sn, kn, fn, and skv.

A comparison between the results of experiments 1 and 2 (which used the same clusters) also shows the same tendencies in both experiments.

The first experiment thus shows the same correlation between percentage frequency of all sound symbolic meanings for a cluster and mean increase in priming speed as in experiments 2 and 3.

An additional result from experiment 3, which used the same subjects in priming and lexical decision conditions, was that subjects vary greatly but are internally consistent. In other words, the subjects who were faster than others were so in all conditions; in baseline and phonaestheme, in priming and isolated lexical decision.

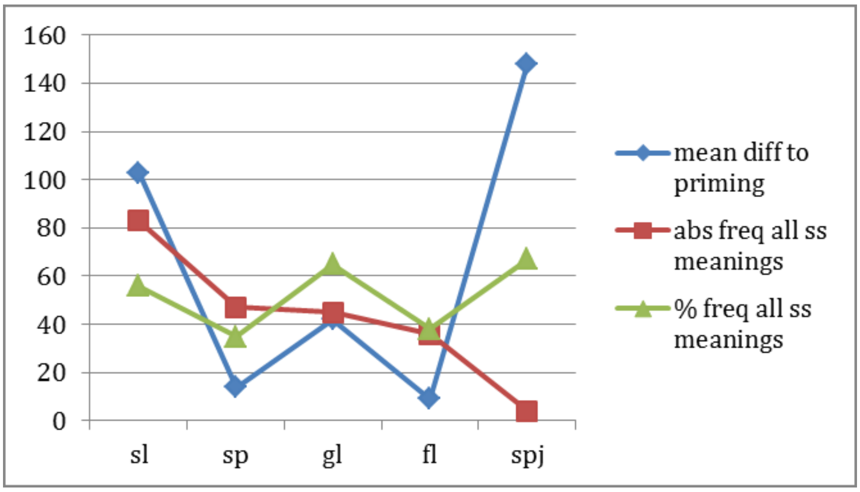

Figure 6. Percentual frequency of all sound symbolic meanings for a cluster in relation to mean priming facilitation. First experiment. Cf. Figure 3 for results from second experiment (the same clusters as in second experiment).

5. Conclusions and Discussion

All three experiments showed the same correlation between increase in priming speed and the phonaesthemes' percentual representation in initial consonant clusters. There is a correlation between mean priming time increase and the percentage of sound symbolic words (all meanings) of any given cluster. The higher the ratio of sound symbolic words (all meanings) for a cluster the more facilitation there is in priming, i.e. the more psychologically real are the phonaesthemes. There is a gradual rather than an absolute difference from somewhat sound symbolic to highly sound symbolic phonaesthemes. Furthermore, the error rates for some words decreased in priming condition.

This holds true irrespective of different word stimuli and different phonaesthemes, and irrespective of whether subjects were different or the same in priming and isolation.

Another important finding is that meaning classes seem to be connected. Phonaesthemes have psychological reality in relation to semantic chains and semantic relations. There was no correlation between frequency in relation to separate meanings and priming facilitation, while there was a clear correlation between frequency in relation to ALL sound symbolic meanings of a cluster and priming facilitation. This could be evidence of lexical organisation in semantic chains such as: sound of movement – movement – moving light; sound of water – wetness – pejorative; bad mood – angry speech – pejorative; round form – putting together; light source (e.g. gleam) – perception of light (e.g. glance) – smooth (potentially reflecting) surface (e.g. glass) – movement on smooth surface (e.g. glide). These related meanings are to a large extent connected by the basic categories similarity or contiguity.

The results shed light on the question of the explanation for phonaesthemes, whether meanings that are clustered around certain sounds are so just by chance usage or whether they are organized in terms of some underlying principle. Most of the meanings of phonaesthemes are connected to auditive, visual or tactile sensation, and to emotions, and can thus be interpreted from an embodied usage based point of view. The meanings of the phonaesthemes in the present experiment were: dryness, wetness, talking, pejorative, round form, thin form, separation, quick movement and light. These meanings are all connected to sensory impressions.

What does the higher priming effect for percentually high frequency clusters represent? In a connectionistic framework it could first be seen as the result of an activation of units based on high relative lexical frequency. When a cluster has a large percentage of words with a certain meaning, the cluster is activated and ready for responding faster than other clusters. Secondly, the priming seems to enhance this reaction speed in a non-linear way.

But why are some phonaesthemes more percentually frequent thereby causing a higher speed of priming? Embodiment is not the only answer, because the phonaesthemes are all embodied. Nor is chance. The percentually most frequent clusters are fn- (dryness) and skv- (wetness). One part of the explanation could be that these clusters are clearly based on onomatopoeia (the sound of scraping on a dry surface and the sound of an object falling into water). These clusters are especially well suited to their meanings, for acoustic-perceptual reasons. Once the proportion of certain meanings accumulates beyond critical mass, words with other meanings are repelled.

In the model of Abelin (1999) onomatopoeia, which fits well into the framework of imitation and mirror neurons, was seen as the basis of meaning extensions into other modalities, sight and touch, and from there to more abstract meanings based on hearing, sight and touch, e.g. form and surface structure. This connects to embodied cognition and is relevant for how a child learns to perceive the world and develops language, interacting with objects with all his or her senses. The categories for phonaesthemes found in Abelin (1999) therefore fit well into an embodied usage based view of language acquisition and language evolution. (Rizzolatti and Arbib (1998) discuss the possibility of gestures, rather than onomatopoeia, being the origin of spoken language owing to mirror neurons and multi-sensory connections. However, mirror neurons can also react to sound impressions.)

The present experiments demonstrated that the phonaesthemes show a correlation between relative frequency and increased priming speed. Frequency is thus relevant. However, the connections between sounds and meanings are not attributable to chance, but may emerge from embodied cognition, based primarily on onomatopoeia. Phonaesthemes can be shaped by the perceptual system that underlies the ability to interact with the environment, and can be activated by interaction with that environment.

Notes

[i] The most succesful phonaesthemes in the production and perception experiments of Abelin (1999) were:

In production: gr-, fn-, sn-, pj-, sk- and spr-.

In interpretation: fj-, fn-, str-, sp-, vr- and pj-.

In production and interpretation: fn- (dryness) and pj- (pejorative).

The clusters bl-, gl- and gn- meaning 'light' were not productive in spite of being percentually lexically high frequency.

References

Abelin, Å. (1996). A lexical decision experiment with onomatopoeic, sound symbolic and arbitrary words. *Speech, Music and Hearing, TMH-QPSR 2/1996*, Stockholm. pp.151–153.

Abelin, Å. (1999). *Studies in Sound Symbolism*. Göteborg,: Göteborg University Dissertations.

Bergen, B.K. (2004). The psychological reality of phonaesthemes. *Language* 80 (2): 290-311.

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

Bolinger, D. (1965). *Forms of English: Accent, Morpheme, Order.* Tokyo: Hokuou Publishing Company.

Farmer, T.A., Christiansen, M.H. and Monaghan P. (2006). Phonological typicality influences on-line sentence comprehension. *Proceedings of the National Academy of Sciences* 103: 12203-12208.

Firth, J.R. (1930). *Speech*. London: Ernest Benn.

Householder, F.W. (1946). On the problem of sound and meaning: An English phonestheme. Discussion in *Language* 23 feb.

MacWhinney, B. (2005). A unified model. In N. Ellis and P.R. Robinson (eds.), *Handbook of Cognitive Linguistics and Second Language Acquisition*. New York: Routledge. pp. 341-371.

Kawahara, S., Shinohara, K., and Uchimoto, Y. (2008). A positional effect in sound symbolism: An experimental study. *Proceedings of the Japan Cognitive Linguistics Association* 8: 417–427.

Kovic, V., Plunkett, K. and Westermann, G. (2010). The shape of words in the brain, *Cognition* 114 (1): 19–28.

Maurer, D., Pathman, T. and Mondloch, C.J. (2006). The shape of boubas: Sound–shape correspondences in toddlers and adults. *Developmental Science* 9(3): 316–322.

Namy, L.L. and Nygaard, L.C. (2008). Perceptual motor constraints on sound-to-meaning correspondence in language. *Behavioral and Brain Sciences* 3: 528–529.

Nygaard, L.C., Cook, A.E. and Namy, L.L. (2009). Sound to meaning correspondences facilitate word learning. *Cognition* 112 (1): 181–186.

Ohala, J.J. (1994). The frequency code underlies the sound-symbolic use of voice pitch. In L. Hinton, J. Nichols and J.J. Ohala (eds.), *Sound Symbolism*. Cambridge: Cambridge University Press. pp. 325–347.

Parault, S.J. and Parkinson, M.M. (2008). Sound symbolic word learning in the middle grades. *Contemporary Educational Psychology* 33: 647-671.

Ramachandran, V.S. and Hubbard, E.M. (2001). Synaesthesia: A window into perception, thought and language. *Journal of Consciousness Studies* 8: 3–34.

Rizzolatti, G. and Arbib, M.A. (1998). Language within our grasp. *Trends in Neurosciences* 21 (5): 188–194.

Wichmann, S., Holman, E.W. and Brown, C.H. (2010). Sound symbolism in basic vocabulary. *Entropy* 12: 844–858.