“Sounds like a rainbow” - sound-colour mappings in vowel perception

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Abstract

The paper reports on an experiment conducted to investigate the nature of speech sound perception in terms of cross-modal mappings between vowel sound stimuli and colour spectrum associations. The study is based on the assumptions stemming from research on synaesthesia, sound symbolism and non-modularity of human perception. The findings indicate that vowel-sound mappings appear non-arbitrary in non-synaesthetic perception and follow the general tendencies in which bright colours are associated with prominent high-pitched sounds, whereas dark colours are attributed to lower-pitched tones. The results may have implications for L2 pronunciation pedagogy in that they may enhance the effectiveness of L2 phonological acquisition.

Key words: sound-colour mappings, vowel colour, synaesthesia

Theoretical assumptions

The application of colour terminology with relation to vowels can be traced back to Jakobson (1962) who pointed to the regularity of colour associations in coloured hearing synaesthesia identifying close connections of vowels /o/ /u/ with darker colours, /e/ /i/ with brighter colours, and /a/ with red. However, very few studies to date have explored the phenomenon of making associations between colour spectrum and speech sounds in normal perception. Flagg and Stewart (1985) claimed that 6 primary colours can be used to facilitate consonantal perception. Dailey et al. (1997) investigated the relation between creativity, synaesthetic tendencies and physiognomic perception. Their findings demonstrated that creative individuals have access to primary thinking processes that assume a unity of different sensory modalities since they exhibited stronger associations between colours and vowels.

Donegan (1985) used the term *vowel colour* to refer to such features as palatality and labiality. She stated that palatal vowels, traditionally referred to as front vowels, which have high F2 and a considerable distance between F1 and F2, tend to be perceived as 'bright' as opposed to 'dark' labial vowels characterised by low F2 and a small distance between F1 and F2. Vowels which are neither palatal or labial are called plain or achromatic.

Finally, researchers report a strong correlation between auditory pitch and visual luminance; there is a general tendency for most people to associate

high pitch sounds with light colours and low tones with dark colours (e.g. Hubbard 1996, Ward et al. 2006). As suggested by Ward et al. (2006), research on synaesthesia can be used “to inform theories of normal cognition”, and further verification is needed of the hypothesis he proposes, which states that mechanisms analogous to the ones used in synaesthetic perception may be recruited in non-synaesthetic cross-modal perception.

Experiment

The aim of the present study was to investigate whether L2 speech sounds evoke associations with specific colours in non-synaesthetic speakers highly proficient in English.

Participants and materials

48 first year students of English at Adam Mickiewicz University in Poznań, Poland took part in the experiment. The participants consisted of 34 females and 14 males and their mean age was 20 years. At the time of the experiment they were ignorant about the phenomenon of synaesthesia and an interview conducted prior to the experiment served to rule out this ability in the tested population.

Sound stimuli used in the experiment included 12 English pure vowel sounds recorded in isolation. The stimuli were recorded by a male native speaker of English (in a professional recording studio) as 16-bit mono files at a sampling frequency of 16000 Hz using Audacity software.

Procedure

The experiment was run on a specially designed computer program, implemented in Visual Basic, that offered the following functionality: (1) playing randomised sounds; (2) displaying the palette of 11 basic colours in a randomised order; (3) registering participants' data and responses. The experiment was carried as a series of individual sessions. The participants were seated in front of a computer screen in a dimmed room. They were instructed to listen to individual sounds and choose one colour from a palette of 11 basic colours, as specified by Berlin and Kay (1969). The test was self-paced and the participants could play a given sound as many times as they wished but once a colour was selected they were not able to modify it. The choice was made by clicking on one of the 11 coloured rectangles presented in 3 rows against a light grey background. The colour palette appeared automatically on the screen with a 2s delay after a 'Play' button was clicked in order to play a particular vowel sound. The whole procedure was repeated after a 7-week interval and yielded a total of 75 sets of responses.

Results and discussion

The SPSS analysis revealed the statistical significance of sound-colour associations for 8 out of 12 English vowels under investigation ($p < .01$). See Table 1 for the results of a nonparametric chi-square test.

Table 2 presents the data generated by the two parts of the experiment ($N=75$), highlighting in yellow these particular colour associations which were above chance level as demonstrated by the chi-square test results.

Table 1. Chi-square analysis for vowel-colour associations in English.

	æ	ɔ:	ʌ	ɑ:	e	ɜ:	ɪ	i:	ɒ	ə	ʊ	u:
chi2	26.6	41.9	14.3	15.5	26.9	40.5	17.5	58	10.2	30.4	50.4	23
df	10	9	10	10	10	10	10	10	10	10	10	9
p	.003	.000	.16	.115	.003	.000	.063	.000	.422	.001	.000	.006

Table 2. Vowel-colour associations for English (highlighted values statistically significant at $p < .01$).

N=75	æ	ɔ:	ʌ	ɑ:	e	ɜ:	ɪ	i:	ɒ	ə	ʊ	u:
grey	7%	11%	15%	3%	4%	20%	17%	3%	11%	23%	28%	7%
brown	5%	29%	4%	9%	4%	19%	7%	1%	4%	8%	17%	24%
yellow	17%	7%	14%	8%	7%	3%	11%	28%	11%	8%	3%	5%
green	5%	8%	14%	7%	16%	7%	11%	20%	4%	13%	8%	8%
orange	11%	4%	11%	7%	15%	1%	16%	9%	12%	13%	9%	11%
black	11%	16%	1%	16%	5%	16%	4%	1%	11%	3%	13%	13%
blue	4%	12%	9%	11%	12%	9%	7%	8%	13%	7%	4%	13%
red	21%	5%	8%	15%	19%	4%	4%	5%	11%	3%	3%	7%
purple	9%	0%	7%	11%	7%	14%	12%	7%	8%	4%	7%	8%
white	4%	4%	11%	12%	1%	1%	5%	13%	12%	13%	4%	0%
pink	5%	4%	7%	3%	8%	5%	7%	4%	4%	5%	4%	4%

Table 3. Statistically significant colour associations for vowel categories.

	Front	Central	Back
yellow	16%		
green	13%		
orange	13%		
grey		19%	14%
brown			19%

	High	Mid	Low
red			15%
grey	14%	13% *	

$p < .001$

Strong correlations were also found when the analysis accounted not for individual sounds but rather vowel categories (front/central/back and

high/mid/low). The assignment of colours was statistically significant in 5 out of 6 categories and in one it approached significance (marked with *, see Table 3).

The present analysis relied mostly on local characteristics of formant frequencies as perceptual parameters used to categorise vowel colour. The findings indicate that vowel-sound mappings in non-synaesthetic perception appear non-arbitrary and follow the general tendencies in which bright colours (yellow, green) are associated with prominent high front vowel sounds, whereas dark colours (brown, blue, black) are attributed to back vowels, open sounds tend to be perceived as red and central vowels are mapped onto achromatic grey. Thus the results seem to corroborate the hypothesis that similar mechanisms may be used in non-synaesthetic and synaesthetic perception of colours and sounds as previously indicated by Ward et al. 2006, however, these mappings cannot be expected to equal the consistency and specificity of colours demonstrated by synaesthetes.

Further research into this phenomenon is definitely needed to verify the hypothesis more thoroughly. Moreover, it may provide specific implications for L2 pronunciation pedagogy and thus may enhance the effectiveness of second language phonological acquisition.

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