VOWEL-COLOUR SYMBOLISM IN ENGLISH AND ARABIC: A COMPARATIVE STUDY

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1. Introduction

The present paper aims at exploring the potential motivated relation between vowel sounds and colours, as well as at expanding the range of languages analysed in this respect so far. To this end, two experiments are presented using the same methodology, a free-forced-choice task, but different language speakers, English and Arabic. In both experiments, participants were asked to listen to a vowel sound and choose a colour from twelve options available. But before detailing the experiments, I will summarize the theoretical background that led the author to study the two apparently unrelated fields of vowel sounds and colours.

1.1. The Linguistic Sign: Perspectives

The phenomenon of sound symbolism had not been openly accepted and studied till relatively recently. During the 20th century a strong debate around the arbitrariness of the linguistic sign took place, where three positions are easily observable. The first position —arbitrary— establishes that there is nothing in nature that may help the speaker use certain sounds to name entities (Saussure 1983; see also Bally 1951; Bloomfield 1933; Bolinger 1950, 1975, 1980; Brekle 1974; Culler 1975; Dubois 1974; Leach 1964; Leech 1969;

Lyons 1977; Meier 1999; Thorndike 1945). The second point of view —motivated— states that language is motivated particularly because there is something in nature that helps speakers know that certain sounds are appropriate for naming certain entities (Coward and Ellis 1977; Durbin 1973; Gabelentz 1891; Hodge and Kress 1988; Houdé *et al.* 2002; Hymes 1960; Jakobson 1971; Jakobson and Waugh 1987; Kress and Leeuwen 1996; Marcos Marín 1997; Monneret 2003, 2005; Nuckolls 1999; Sereno 1994; Toussaint 1983; Ultan 1978; Wilden 1987). The third perspective —middle-ground— agrees partially with the previous two by considering that there is a scale that goes from the most arbitrary elements in language to the most motivated signs. One of the reasons put forward in favour of this argument is that the dichotomy *signifier-signified* is too simplistic, and that the linguistic sign is made up of different layers, some arbitrary and some extremely motivated (see Bouissac 2003; Fill 2005; Fischer 1999; Haiman 1999; Magnus 2000; Nöth 1990; Waugh 1993).

1.2. Sound Symbolism: Typology

All the definitions of sound symbolism seem to coincide in the idea that it is the motivated relationship between the formal elements in a word and its meaning component. This makes sound symbolism a very general concept which may be divided into different categories that have received different degrees of attention. The most common types of sound symbolism may be reduced to four: corporeal, imitative, conventional and synesthetic (for an in-depth review of this typology see Hinton et al. 1994). Corporeal symbolism (Ostwald 1994) refers to the sounds speakers produce when expressing a physical or psychological state (e.g. grumbling when angry). Imitative symbolism (Grammont 1993; Jespersen 1922; Radden and Panther 2004; Tsur 2001) —i.e. onomatopoeia— implies the imitation of natural sounds using linguistic elements (e.g. saying *bow-bow* to represent the barking of a dog). Conventional sound symbolism (Bergen 2004; Lázaro Carreter 1977) —i.e. phonesthemes— deals with the association between certain consonants or consonant clusters and certain meanings (e.g. the cluster /fl-/ is usually associated with "moving light" as in *flash, flare, flame* or with "movement in air" as in *fly, flap, flip*). Synaesthetic sound symbolism (Aoki 1994: 15; Bolinger 1980: 19; Hinton et al. 1994: 4) considers the association between sounds and the physical characteristics of objects, such as colour, shape, size or temperature. For instance, the pair *maluma* and *takete* has been associated by participants with rounded and spiky figures respectively (see Davis 1961; Fox 1935; Irwin and Newland 1940; Köhler 1929; Maurer et al. 2006; Rogers and Ross 1975). In terms of research effort, this last type is the one that has received most attention.

1.3. Synaesthetic Sound Symbolism: Research Methods

Depending on the purpose of the research, different methodologies can be observed within the study of sound symbolism with non-synesthetic participants. As a case in point, the free-production task has been commonly used with the aim of analyzing the productivity of the phenomenon. This consists firstly of asking participants to provide a name for a given object considering certain characteristics such as its size or shape (see Bentley and Varon 1933; Iritani 1969; Johnson 1967; Klank et al. 1971). Secondly, in order to study the automatic activation of the sound-symbolic process, different variations of the Stroop task (Stroop 1935) have also been employed (see Beeli et al. 2005; Westbury 2005). In an original Stroop task names of colours are displayed in the same or a different colour from the one denoted by the name, and participants are required to say the name of the colour. In principle, it will take them longer to recognise, for example, the name of the colour yellow if this is displayed in blue, than if both colour and name match. Thirdly, when the objective is that of obtaining quantifiable data from the connotative meaning of a word or concept, rating scales are used (Bentley and Varon 1933; Fischer-Jørgensen 1978; Gebels 1969; Heise 1966; Marks 1982; Miron 1961; Taylor and Taylor 1962). Finally, matching tasks are perhaps the most common type of technique employed when dealing with synesthetic sound symbolism (see e.g. Bentley and Varon 1933; Brackbill and Little 1957; Brown et al. 1955; Davis 1961; Maurer et al. 2006; Miyahara et al. 2006; Newman 1933; Sapir 1929; Tarte and Barrit 1971; Tsuru and Fries 1933; Usnadze 1924; Wrembel 2007, 2009). The main purpose of these tasks is to obtain knowledge on how the form of a word provides information, so that participants are able to relate it to a certain meaning; or, conversely, how the physical characteristics of an entity may give speakers clues about which string of sounds would be appropriate to name it.

Despite the great variations in the use of the methodologies outlined above, some findings seem to be common to most of them. In the first place, the way in which stimuli are presented —visually, auditorily, framed by consonants or alone — does not influence results (Taylor and Taylor 1962). Secondly, even if the strength of the associations seems to vary depending on the language studied, the phenomenon itself seems to be universal. In addition, the normal population seems to recognize sound-symbolic elements on the basis of a combination of their experience of the world and their innate predisposition towards this phenomenon (Abelin 1999; Brown 1958; Cytowic 1989; Lakoff and Johnson 1980; Werner and Kaplan 1963). Furthermore, sound symbolism seems to be found particularly in those word pairs referring to *sensible* continua, such as magnitude or shape (Brown and Nuttall 1959: 445; see also Birch and Erickson 1958; Brown 1958). Moreover, in general terms, age does not seem to influence speakers' ability to perceive sound

symbolism (Maurer et al. 2006; Newman 1933). Finally, findings in studies such as Roper *et al.* (1976) point towards a statistical difference between male and female participants in terms of the types of sound symbolic relations established by children when asked to classify non-sense words in terms of size or texture and colour. Roper et al. (1976: 393) found that male participants in their study chose black for soft words, whereas females chose white tokens (F= 15.75, d.f. = 1.28, *p<0.01*).

2. Experiments

2.1. Introduction

As explained above, the findings obtained in studies carried out with non-synesthetes have determined that the latter have the ability to associate sounds and properties of objects to a better than chance degree in most of the cases. At the same time, the existence of an automatic innate condition called synesthesia is widely known. Those who possess this condition automatically associate sensations emanating from two senses or from two dimensions of the same sense (e.g. a synaesthete may listen to vowel /a/ and simultaneously see the colour red, or read the word *Wednesday* and automatically see the colour blue). Most studies of the synaesthetes' association between sounds or letters and meanings consist in the experimenter asking the participant which sound, letter or word is connected with which colour (Rich *et al.* 2005; Simner *et al.* 2005; Weiss *et al.* 2001). Most of the experiments carried out in this respect have found that: a) synaesthesia is more frequent in women than in men and that it is hereditary (see also Bailey and Johnson 1997; Baron-Cohen *et al.* 1996); b) synaesthesia is equally present in left- and right-handed people; c) a synaesthete's life tends to be connected with artistic activities; d) synaesthetes tend to be worse at direction finding and mathematics than non-synaesthetes; and e) the associations established are not purely idiosyncratic[1].

In most cases, the study of the synaesthetes' responses has been compared with those of a non-synesthetic control group tested under the same conditions. The results of all the studies carried out in this respect (see e.g. Baron-Cohen *et al.* 1993) show that the control group performs poorly in comparison with the experimental group of synaesthetes. Nevertheless, other studies (Rich *et al.* 2005) have also found that, even if non-synaesthetes are not able to recall so well their first choices when retested, some commonalities between both groups can be observed. This suggests that "common experiences may underlie the links evident in the two groups" (Rich *et al.* 2005: 78).

Despite the existence of a great deal of theoretical and experimental work on synaesthetic associations, few empirical studies have so far investigated the association between sounds and colours as perceived by non-synaesthete participants. Exceptions are the studies by Miyahara et al. (2006), Wrembel (2007, 2009), and similar work by Wrembel and Rataj (2008). These authors used matching tasks asking participants from different languages (Japanese, English, Polish) to listen to sounds and choose the colours they considered appropriate. In all three cases, the authors found statistically significant associations between both elements. For example, Miyahara et al. (2006) observed that /a/ was mostly related with red, /i/ with yellow, /u/ and /o/ with blue and green, and /e/ with green. Moreover Wrembel (2007, 2009) and Wrembel and Rataj (2008) also observed significant associations and reached the conclusion that for both Polish and English there was a tendency to associate bright colours with front vowels and dark colours with back vowels. However, despite the coincidences observed by both authors within this specific type of association, the findings obtained in synaesthetic sound symbolism in general are not completely conclusive (Kennedy and Ross 1975; Miron 1961; O'Boyle *et al.* 1987; Rogers and Ross 1975; Slobin 1968; Taylor 1963). The results available seem to point towards a type of sound symbolism that may be common to certain languages, though somehow conditioned by the family to which they belong.

Given the few empirical studies available on the relation between sounds and colours in non-synaesthetes, further research seems necessary by expanding the range of languages studied. Therefore, the aim of the experiments described below is to gain a better understanding of such associations in the non-synesthete population. More specifically, the research questions to be answered in this paper are: a) Do non-synaesthetes associate sounds and colours significantly? and b) Are these associations cross-linguistic?

As far as the first research question is concerned, the results and conclusions derived from the studies of the general sound symbolism literature permit us to hypothesize that participants should be able to establish some degree of association between sounds and colours. With regard to the second research question, the literature on the universality of sound symbolism is extensive. However, based on the findings and conclusions derived from the studies on sound symbolism, the hypothesis proposed in this study is that there will be coincidences in the associations established, though these will be conditioned by linguistic and cultural factors.

In order to test these hypotheses, a free-forced-choice task was carried out, using two groups of language speakers, English and Arabic.

2.2. Method: Experiment 1 English

2.2.1. Participants

Fifty-six undergraduate students (ten male and 46 female) from the School of Psychology at the University of Birmingham (UK) were considered for this experiment. Most of them had little or no knowledge of other languages. Four of them were ruled out because they were bilinguals in English and one of the following languages: French, Gurajati, Punjabi or Turkish. Therefore, the data provided by 52 participants (nine male and 43 female; mean age 19.9 years, SD = 0.9) was taken into account. Mono-lingualism was considered relevant in the two experiments, since it has been well proved that it is very important to use monolingual participants in studies attempting to determine the relation between sound and any type of meaning in a given language (see Taylor and Taylor 1962: 354), since the perfect command of a non-native language may condition the results obtained.

Before participating in the experiment, subjects carried out a colour-blindness test. Only after passing this test could they have access to the experiment. All participants passed this test, which means that none of them were colour-blind and therefore they qualified as subjects for this experiment. They were also asked whether they suffered from auditory or visual problems. All of them answered *no* to these questions, and so they were considered apt subjects.

2.2.2. Stimuli and Materials

The stimuli used came from different sources. For the sound stimuli, cardinal vowels were taken from an Interactive CD containing a clickable cardinal vowel chart created by the Department of Phonetics and Linguistics at University College London.

Cardinal vowels are not language-specific. They are produced when the tongue occupies an extreme position within the mouth (either front, back, low or high). They represent reference points used by phoneticians in order to study and describe the vowels of the world's languages. The system was designed by Jones ([1918]1967), who defined two vowels, [i] and [ɑ], from an articulatory point of view. Then, the other vowels were located as auditorily equidistant between these three vowels, always taking into account four degrees of height: close, close-mid, open-mid and open (see Ladefoged 1971: 67). The different degrees of aperture together with the distinction established between front and back gave as a result the eight reference points that came from a set of articulatory and auditory criteria. The resulting vowel chart is shown in Figure 1.
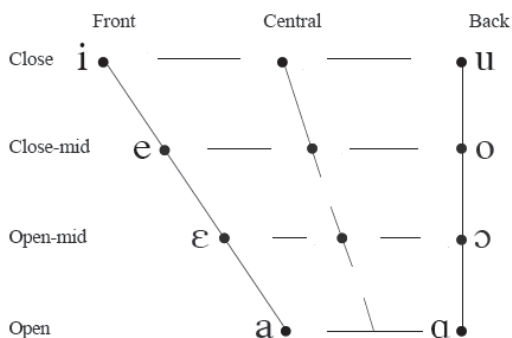
FIGURE 1: Primary Cardinal vowel chart.

From all the vowels available on the CD, only the eight primary cardinal vowels (/i/, /e/, /ɛ/, /a/, /ɑ/, /ɔ/, /o/, /u/) were used. All of them were 16-bit stereo files (sampling frequency 44,100 Hz and 65 dB).

As far as the colours are concerned, they were created by means of *Paint Brush*, a graphics painting program for creating different pictures and painting them in customized colours. In line with Berlin and Kay's (1969) findings, the colours used in this experiment were black, blue, brown, green, grey, yellow, orange, pink, red, white and purple. A twelfth option was provided so that participants could choose it whenever they felt that none of the colours provided matched the sound they had heard. Each colour was created following the additive system RGB, which combines the three colours —red, green and blue— in different measures in order to produce other colours. The coloured squares appeared against a soft silver background, so that the contrast between the colours and the background was not extreme. The silver background was also used with the intention of using white as one of the potential choices. The test was located on the Internet at http://www.lasnorias.es/pilar.

The experiment was carried out on a desktop computer with a 17-inch screen located at a laboratory of the School of Psychology (University of Birmingham). Headphones were also used in order to isolate the participant from the surrounding environment. The room was dimmed by means of curtains and no lights were turned on while the experiment was being carried out, so as to avoid potential light reflection on the screen.

2.2.3. Procedure

Participants were tested one by one and given a pre-experimental consent form. After that, the experimenter explained the procedure to the participant in their

native language. In the software designed for the purpose of this experiment, participants were first asked to choose their native language. After that, another screen appeared where the instructions were shown (see Figure 2).

1. In this experiment you will be asked to listen to a sound and to choose from eleven colours, the one you think best fits the sound you have listened to.

2. There will also be an 'I don't know' option that you can choose whenever you feel that the sound does not relate to any of the colours.

3. There are not right or wrong answers, so just choose the option that first comes to your mind.

4. Before the test, you will be required to do a brief colour-blindness pre-test.

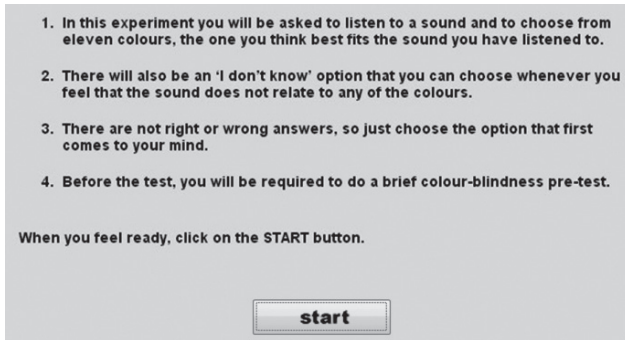When you feel ready, click on the START button.

start

FIGURE 2: Instructions for the experiment.

38

After clicking on the START button, they were redirected to another screen, with questions about: age, gender, handedness, auditory problems and colour-blindness. Then, the program directed participants to a colour-blindness test in which the Ishihara plates 1, 13 and 23 (Ishihara 1917) were used (see Figure 3).
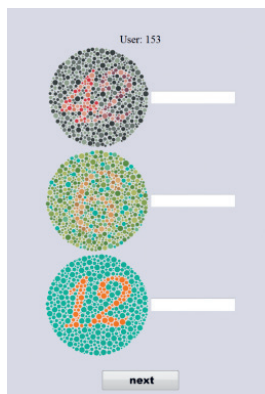

FIGURE 3: Colour-blindness test.

If they passed this test, the programme showed the first of the thirty-two slides the experiment consisted of. First, participants listened to a sound and then they saw 12 coloured squares on the screen (see Figure 4).
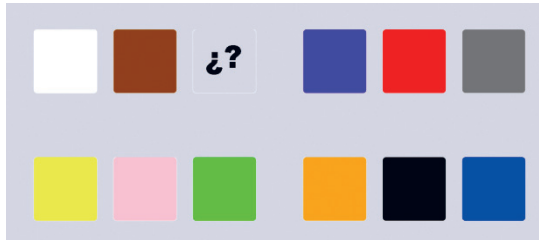

FIGURE 4: Example of experiment screen.

The images occupied the whole screen and only when participants had clicked on a given colour, did the next sound and image appear. Each of the eight sounds used were heard four times with colours varying in the position they appeared on the screen, so that potential results could not be attributed to the position of colours on the screen. Finally, participants proceeded to a post-experiment written questionnaire.

2.2.4. Results

The data collected from the English subjects were ordered and analysed by means of a Chi-square test in order to measure the deviation of the sample from expectation as well as the statistical significance of the associations in comparison with those established between the same sound and other colours. The data obtained as well as the Chi-square values showing significant associations are shown in Table 1.

VOWEL	ENGLISH
/i/	**GREEN** ($X^2(1)$=25.18, **p<0.005**)
/e/	**GREY** ($X^2(1)$=7.67, **p<0.01**)
/ɛ/	**ORANGE** ($X^2(1)$=8.59, **p<0.005**) **WHITE** ($X^2(1)$=25.79, **p<0.005**)
/a/	**RED** ($X^2(1)$=8.76, **p<0.005**)
/ɑ/	**RED** ($X^2(1)$=28.39, **p<0.005**)
/ɔ/	**ORANGE** ($X^2(1)$=16.25, **p<0.005**)
/o/	**ORANGE** ($X^2(1)$=8.59, **p<0.005**)
/u/	**BROWN** ($X^2(1)$=19.49, **p<0.005**)

TABLE 1: Chi-square results for English participants.

As observed in Table 1, participants significantly associated the sounds with one or even two colours. The deviation of the choice of the colours with respect to the association with other colours is statistically significant by p<0.005, except for that established between /e/ and grey (p<0.01). Specifically, the English participants chose: a) green for /i/, b) grey for /e/, c) orange and white for /ɛ/, d) red for /a/ and /ɑ/, e) orange for /ɔ/ and /o/, and f) brown for the vowel /u/. This implies that the first hypothesis that there would be some degree of association between sounds and colours is confirmed for the English participants.

Nonetheless, even though the data gathered support the hypothesis proposed, a within-group analysis reveals variability in terms of the choices made. These choices were of five different kinds: a) the same colour was chosen the four times the sound was listened to (4); b) two different colours were chosen the four times the sound was listened to (2+2); c) the same colour was chosen three times and a different colour was selected once (3+1); d) the same colour was chosen twice, whereas two other different colours were selected for the remaining two times in which the sound was listened to (2+1+1); and e) four different colours were selected each of the four times the sound was listened to (1+1+1+1). As observed from the data reported in Table 2, a low percentage of participants chose the same colour on all occasions. Most participants seem to have followed options *c*, *d* and *e*. This shows that within-group variability existed, even though it did not influence the general results obtained.

	4	2+2	3+1	2+1+1	1+1+1+1
/i/	5.7%	9.6%	36.5%	21.1%	26.9%
/e/	9.6%	3.8%	21.5%	25 %	38.4%
/ɛ/	17.3%	3.8%	21.5%	36.5%	21.5%
/a/	7.7%	5.7%	26.9%	32.7%	26.9%
/ɑ/	17.3%	11.5%	19.2%	32.7%	19.2%
/ɔ/	11.5%	7.7%	15.3%	50 %	15.3%
/o/	9.6%	3.8%	17.3%	34.6%	36.5%
/u/	7.7%	7.7%	25 %	32.7%	26.9%

TABLE 2: Within-group variability in terms of colours choice. English participants.

2.3. Method: Experiment 2 Arabic

2.3.1. Participants

For this experiment, 50 Arabic speakers were initially taken from different groups. These included Arabic speakers living in Tetuan and Dar Bouazza (Morocco), as well as other speakers living in the Region of Murcia (Spain).

All participants were native speakers of classic Arabic, Darija (the Moroccan dialect) or both. Two would-be participants were excluded, since they had spent more than ten years in Spain and Spanish had become their first language. The other 48 participants spoke other languages, especially Spanish, English and French, but were not considered bilingual, because all of them had learnt these languages later in life and they described their linguistic competence as basic. Even those living in Spain did not have a good command of Spanish and the experimenter took the trouble to create an Arabic-speaking environment, by providing instructions and questionnaires in Arabic and not speaking to them during the experiment. None of the participants had auditory or visual problems, and all of them passed the colour-blindness test. The educational level of the 48 participants (29 male and 19 female) ranged from secondary school to undergraduate students. Their mean age was 24.8 years (SD=2.3).

Arabic was chosen because, unlike English, all the colour words in Arabic, except the equivalent of *brown* and *orange*, contain predominantly the vowel /a/: أسود (aswad) black, أبيض (abyadh) white, أحمر (ahhmar) red, أصفر (assfar) yellow, أزرق (azraq) blue, أخضر (akh-dhar) green, بنّي (onniy) brown, ورديّ–زهريّ (wardiy/zahriy) pink, برتقالي (burtuqaaliy) orange, رمادي (ramaadiy) grey, بنفسجيّ (banafsajiy) purple. Using Arabic as the other language for this experiment made possible not only a study of the universality of the phenomenon —since Arabic belongs to a different language family— but also an analysis of the relevance of pronunciation and spelling in the process of establishing these associations.

2.3.2. Stimuli and Materials

The stimuli were exactly the same as the ones used in Experiment 1. There was variability regarding the computer used, for two reasons: first, it was not possible to take a desktop computer to the location where the experiments were taking place; second, even if such option were possible, the Internet could not be relied on to work everywhere; therefore, a wireless connection had to be used. This meant that for the groups living in Morocco, a laptop computer with a 10.1-inch screen was used. This, however, was not considered a problem, since the coloured-squares occupied the whole screen and the light silver background filled the spaces between them. Consequently, even if the size of the images was smaller, the quality was not diminished. For the other groups, a laptop computer with a 15-inch screen

was used. No colour problems were presented, since the colours occupied the whole screen and a colour test was run in order to make sure that the hue and saturation were the same as the ones appearing in the previous experiment. All the tests were performed in a quiet and dimmed environment, where participants could carry out the experiment without any external element interfering in their performance.

2.3.3. Procedure

The procedure was basically the same as the one followed in the previous experiment. In order to avoid language interference, the instructions were made available in the written format including details found relevant in the light of experience with the previous group. They were provided in Darija, so that no further explanation in a language different from the participants' native one was necessary.

2.3.4. Results

The data derived from the Chi-square test reveal that there was a certain pattern in the associations made between sounds and colours. However the level of significance is not as high as the one found for English speakers (see Table 3).

VOWEL	ARABIC
/i/	**GREY** ($X^2(1)$=9.82, **p<0.005**)
/e/	**GREEN** ($X^2(1)$=4.88, **p<0.05**) **PINK** ($X^2(1)$=4.32, **p<0.05**)
/ɛ/	**GREEN** ($X^2(1)$=9.32, **p<0.005**)
/a/	**BLUE** ($X^2(1)$=4.04, **p<0.05**) **GREEN** ($X^2(1)$=4.00, **p<0.05**)
/ɑ/	**RED** ($X^2(1)$=8.87, **p<0.005**)
/ɔ/	**BLACK** ($X^2(1)$=4.04, **p<0.05**)
/o/	**BROWN** ($X^2(1)$=5.30, **p<0.025**) **ORANGE** ($X^2(1)$=5.87, **p<0.025**)
/u/	**PINK** ($X^2(1)$=4.32, **p<0.05**) **RED** ($X^2(1)$=6.35, **p<0.025**)

TABLE 3: Chi-square results for Arabic participants.

As shown in Table 3, the Arabic participants did not establish such strong correspondences between vowel sounds and colours as the English speakers. In four out of eight cases, more than one colour was chosen for a single vowel. For example, green and pink were chosen for /e/ with the same degree of significance, and the same happened with blue and green chosen for /a/, with brown and orange chosen for /o/, and with pink and red chosen for /u/. For the other vowels, higher deviation from expectation was found. For instance, grey was associated with /i/ ($p < 0.005$), /ɛ/ with green ($p < 0.005$), /ɑ/ with red ($p < 0.005$), and /ɔ/ with black ($p < 0.05$). Nevertheless, even though the associations are not as strong as in English, they are still significant.

As was the case with the English participants, within-group variability was observed. Again, participants did not follow a single choice pattern but performed the same types of choices as the English participants: a) same colour (4); b) two different colours (2+2); c) same colour three times and a different colour once (3+1); d) same colour twice and two other different colours (2+1+1); and e) four different colours (1+1+1+1).

In this case, the three last modalities of colour selection seem to predominate, particularly type *d*, with values that reach almost 50% of the choices performed (see Table 4).

10	4	2+2	3+1	2+1+1	1+1+1+1
/i/	2.08%	0%	**22.90%**	**43.75%**	**31.25%**
/e/	2.08%	6.25%	**10.40%**	**41.67%**	**39.60%**
/ɛ/	2.08%	0.00%	**14.60%**	**45.80%**	**37.50%**
/a/	6.25%	2.08%	**10.40%**	**41.67%**	**39.60%**
/ɑ/	2.08%	2.08%	**25%**	**37.50%**	**35.40%**
/ɔ/	0.00%	2.08%	**10.40%**	**50%**	**37.50%**
/o/	0.00%	6.25%	**12.50%**	**50%**	**31.25%**
/u/	4.15%	2.08%	**6.25%**	**43.75%**	**43.75%**

TABLE 4: Within-group variability in terms of colours choice. Arabic participants.

2.4. General Discussion

The analyses of the results obtained for the two languages provide an answer to the first research question, that is, whether there would be some degree of association between sounds and colours or not. The data collected show that participants in both languages established statistically significant associations between the cardinal vowels presented and the colours available.

Compared with other studies carried out on the association between vowel sounds and colours by non-synaesthetes (see Miyahara *et al.* 2006; Wrembel 2007, 2009; Wrembel and Rataj 2008), these results seem to follow the general trend observed so far. As can be observed, general trends and commonalities are found between the vowels, with those belonging to the *front-open* spectrum connected with red, those located at the *front-mid* spectrum to green, those of the *front-close* spectrum with yellow, green and grey, those of the *back-mid* spectrum with brown, orange and black, and those situated at the *back-close* spectrum showing less agreement and related to blue, green, brown, black, purple or pink (see Table 5).

AUTHORS	Fr.-Open	Fr.-mid	Fr.-close	B.-mid	B.-close
Miyahara et al. (2006) JAPANESE	/a/ red	/e/ green	/i/ yellow	/o/ blue (green)	/u/ blue (green)
Wrembel (2007) POLISH	/a/ red	/e/ green (blue)	/i/ yellow (green)	/o/ blue/orange	/u/ black (blue)
			/ɨ/ grey		
Wrembel (2009) ENGLISH	/æ/ red	/e/ blue (green/red)	/iː/yellow (green)	/ɔː/ brown	/ʊ/ brown (black)
	/ɑː/ red (brown)		/ɪ/ blue (grey)	/ɒ/ orange	uː/ brown (grey)
Wrembel and Rataj (2008)	/æ/ red (yellow)	/e/ green (blue)	/iː/yellow (green)	/ɔː/ brown (black)	/ʊ/ orange (purple/grey)
ENGLISH	/ɑː/ red (black)		/ɪ/grey (green/yellow)	/ɒ/ black (blue)	/uː/ brown (blue)
Mompeán	/a/ red	/e/ grey	/i/ green	/o/ orange	/u/ brown
ENGLISH	/ɑ/ red	/ɛ/ orange (white)		/ɔ/ orange	
Mompeán ARABIC	/a/ blue (green)	/e/ green (pink)	/i/ grey	/o/ brown (orange)	/u/ pink (red)
	/ɑ/ red	/ɛ/ green		/ɔ/ black	

TABLE 5: Sound-colour associations in terms of the different vowel spectrums.

However, it is important to point out that the results of the two experiments also show considerable differences when the answers provided by the participants of the two languages are considered, which confirms the hypothesis proposed, that some common elements would be observed, though results would be determined by other factors. Comparing the results of the two-language experiments, it can be

observed that, with the exception of the pervasive and strong associations between /ɑ/ and red and between orange and /o/, the two languages never coincide in the associations established. This shows that even if there are some common features, considerable variability can also be found which may be caused by linguistic, cultural or even idiosyncratic factors.

Factors of a linguistic nature that may have influenced the making of associations would include pronunciation and spelling. For example, English participants strongly associated vowel /i/ with colour *green*, probably influenced by the fact that the only vowel present in the name of the colour *green* is /iː/ very near cardinal vowel /i/, i.e. /griːn/. This type of factor could not be observed in the Arabic participants, since as outlined above (see section 2.3.1) most of the nouns used to name colours in Arabic contain almost exclusively the vowel /a/. In fact, during the experiment, two Arabic participants commented to the experimenter on their difficulty in finding a colour that matched the sounds they were listening to, since no pronunciation factor could help them in their choices. Consequently, they had to look for other clues in order to match the colours with the sounds. For example, even though none of the participants in this study was bilingual in Arabic and another language, they could have made use of their more rudimentary acquaintance with other languages in order to establish the associations. Although this is a feasible possibility, it was not explicitly stated by the participants in any of the post-experiment questionnaires nor was it commented on to the experimenter. Therefore a linguistic factor that may certainly have influenced Arabic participants' results is the language's vowel inventory. In this respect, the Arabic vowel inventory has only three vowels, which may be either short [a, i, u] or long [aː, iː, uː] (IPA 1999). The shorter repertoire of Arabic vowels —in comparison with the British English one— is present in Arabic may be the cause of the greater variability observed, and hence the weaker degree of association between sounds and colours.

A second type of factor that may have influenced the results is cultural. It is possible that the cultural environment influences not only participants' choices but also participants' preferences for certain colours. For example, in the Arabic culture, the colour *green* is of paramount importance, and it is in fact present in all the Arab flags and considered a pan-Arab colour. It implies fertility and strength and is considered a very positive colour (see Beam 2009). This may have prompted Arabic participants to choose *green* for 3 out of the 8 vowels listened to. Another example is the case of *black*, traditionally associated with notions of darkness, pain, sadness, dirtiness or the unknown (Morton 1997; Sherman and Clore 2009). When *black* was significantly associated with a given vowel, it was related to /ɔ/ in Arabic. The reason for this may be that just in the same way as the colour *black* is related to the aforementioned notions, so the vowel /ɔ/ is situated far back in the

45

mouth and so could somehow be perceived as being darker and less clear than the front vowels (Tsur 1992: 20). This could explain why, by the same token, colours such as *green*, *pink* or *yellow*, normally associated with happiness, hope or luck (Morton 1997), are related to front vowels, which may be perceived as clearer and brighter than their back counterparts (Tsur 1992: 20).

Idiosyncratic factors may have also influenced the variability in terms of results across languages. In fact, one of the characteristics attributed to synaesthesia is that it is highly idiosyncratic (Gage 2000: 265; Grossenbacher and Lovelace 2001: 38). Therefore, if those who automatically associate sounds and colour respond to a wide variety of personal characteristics, the least we might expect is that this would also be a feature of non-synaesthetes' sound-colour associations. The participants' experience with colours may have led them to choose certain ones and to avoid others. There were even participants who did not choose specific colours for any of the vowels. For example, the Arabic participant 143 never chose white for any of the eight vowels. This seems to be a constant in the choices made by the Arabic participants, who did not relate white to any of the 8 vowels proposed to them, probably because white in the Arab culture is in certain cases related to mourning (Wiegand and Waloszek 2007).

3. Conclusion

The present paper aimed at contributing to the field of sound symbolism and, more specifically, to provide evidence for the existence of synaesthetic sound symbolism in the general population. To this end, two experiments were made, designed to help provide answers to certain hitherto unanswered questions. Roughly speaking, the evidence obtained through these experiments shows that: a) participants drawn at random from the population are able to establish significant associations between vowel sounds and colours to a better than chance degree; b) the phenomenon is conditioned by linguistic, cultural and even idiosyncratic factors.

Even though the results obtained are limited, different fields could benefit from experimental research of the type presented in this paper. One of such fields is the development of devices that enable blind or deaf people to access information about the world. For example, a device called *the vOICe* is able to create artificial or virtual synaesthesia in such a way that blind people can replace the impaired sense by another one in working order by means of the neural joining of those two senses. Deaf people can also benefit from progress in this type of research. As a case in point, Zahorian (1988: 1539) developed a computer-based visual speech articulation training system that helped hearing-impaired people. Within

the teaching-learning process, the findings obtained in the research on sound-colour synaesthetic associations can also contribute to the better learning of the pronunciation of foreign languages. For example, Spanish learners of English find it very difficult to learn the pronunciation of certain English vowel sounds, due to the fact that the Spanish vowel repertoire contains far fewer vowels than the English one (Lado 1956). If, by means of research on synaesthetic associations, it is known that speakers relate a given sound with a certain meaning, teaching students the different phonetic symbols displayed in those colours may contribute to faster learning, better recall and more accurate pronunciation.

Of course, to achieve such objectives, the field needs to expand and incorporate more experimental research. As a case in point, only three language families have been considered so far. It is therefore desirable that the same method be employed with other different language groups, so that the cross-linguistic character of the phenomenon can be strongly supported or rejected. As far as the different types of participants are concerned, the possibilities are innumerable. The same or adapted experiment could be carried out with people suffering from mental disabilities or brain damage. For instance, it has been shown that participants with damage to the left hemisphere perform badly on the Farnsworth-Munsell colour discrimination test[2], and that this poor performance is related to aphasia or language disorders (Tzavaras and Goldblum 1972). This indicates that colour perception problems seem to be correlated with language deficits, since both result from damage in the same area of the brain. Future research could also consider how bilingual speakers of various languages behave when asked to choose a colour for a certain sound. This kind of experiment could be performed as well with children and the data could be compared to those obtained from adults to test the correlation between sound symbolism and age. Of course, other experimental methods and different stimuli could be used for the study of the relation between sounds and colours.

The field of sound symbolism is very extensive and many issues need further research in order to obtain stronger conclusions. Nonetheless, the revival this area of language research is enjoying nowadays guarantees that many of the controversies related to this field will be, if not solved, at least, thoroughly and deeply discussed.

47

Notes

1. See Baron-Cohen *et al.* (1993) for an opposite conclusion in this respect.

2. This test consists of four trays that contain 85 removable colour caps spanning the visible spectrum. In order to detect the subject's vision abnormalities, he is asked to place the colour caps in order of hue (see e.g. Rigby *et al.* 1991).

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52