

# A Comparison of Cognitive Colour Processing in Bicultural Bilingual Elementary School Children Residing in the UK and Japan

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## Abstract

The 'Linguistic Relativity hypothesis' states that speakers of two languages that have differing concepts, may view the world differently when using those languages. Some languages express the notion of colours distinctively and have differing verbal labels for them, English for example does not have separate lexical terminology for light or sky blue and blue, they are both the same colour, albeit with several shades apart. The Japanese language does, and light blue is termed 'mizu iro', literally water colour, which distinguishes it from the colour blue which is called 'ao'. This paper aims to examine whether the consequences of being brought up bilingually in both the English and Japanese languages has an influence on the perception and cognitive processing of blue stimuli. Results showed that despite both groups being brought up bilingually there was no cognitive shift in how the children processed the sets of blue colour pairs. This is probably due to the fact that the children's L2 speaking frequency did not exceed their L1 speaking times, a situation you would expect for children growing up and being schooled in the L1 country. It is therefore argued that for there to be a cognitive shift in colour processing and perception the children would have to be residing in or have lived in the L2 country for a considerable period.

【Keywords: Linguistic relativity hypothesis / child bilingualism / colour perception】

## Introduction

Humans communicate with each other in a variety of languages and these languages are different grammatically, phonetically and lexically. One particular language may have verbal labels for concepts and notions that other languages may not use. The theory of how the language we speak influences the way we think is a notion that is at the heart of the 'linguistic relativity hypothesis' (Whorf, 1956). In its strong form the theory suggests that language shapes thought and is therefore constrained by language. This would mean that people view the world according to the semantic categories of their native language. This could mean that if a language does not have a definition for a certain concept then that concept does not exist in the eyes of the speaker of that language. This 'strong version' however has been discredited

within the field of linguistics. Athanasopoulos (2012) for example, suggests that people have the ability to grasp concepts even if they are unable to understand them linguistically. The weak version of the theory however has attracted academic attention and been empirically tested. Athanasopoulos (2009) states that this version stipulates that “our thought is not limited by linguistic concepts, but we pay more attention to those aspects of the world that are encoded in our language than to those that are not” (p.83).

The ‘Linguistic Relativity hypothesis’ has attracted scholarly interest within the field of bilingualism and how bilinguals who speak two languages that have differing concepts, may view the world differently when using those languages. Specifically, as Athanasopoulos & Kasai (2008) state “Does the first language (L1) fix cognitive dispositions once and for all, or can the acquisition of a second language (L2) with different conceptual properties from the L1 reorganize cognition according to the distinctions made in it?” (p.106). The three main areas that have attracted academics to the concept of linguistic relativity and bilingualism are grammatical numbering, motion events and colour and bilingual cognition. Pavlenko (2005) states that colour cognition in relation to the linguistic relativity hypothesis has been at the forefront of linguistic debate for decades mainly because some languages express the notion of colours distinctively and have differing verbal labels for them.

The majority of the current research supports the notion that language is a determining factor when participants discriminate and categorize colour (Athanasopoulos et al. 2011). This body of research has verified that participants are more likely to perceive colours as being similar if they share the same lexical term within their own language even if the colours are different in terms of shade (Kay & Regier, 2006, 2007). Looking specifically at the colour blue, a study by Winawer et al. (2007) found that Russian speakers distinguished more readily between a light and dark shade of blue than English speakers. They concluded that this was the result of the Russian language making a lexical distinction between the two types of blue, which English does not.

Studies such as Winawer et al. (2007) indicate that there is a strong relationship between linguistic concepts and cognition. The focus of this kind of research has now been expanded to examine the perception of colours in bilinguals. Athanasopoulos (2009) examined shades of blue in the Greek language that are labeled ‘ble’ for a darker shade and ‘ghalazio’ for a lighter shade of blue. English does not have such a lexical distinction. He asked Greek-English bilinguals and English monolinguals to judge the similarities of light blue and dark blue squares. His results showed that the bilingual speakers within his study who had resided in the UK for more than two years behaved like English monolinguals in their perception of the two shades of blue. That is, they perceived no difference. He concluded that the amount of time spent in the L2 country can cause this shift towards the L2 norm in their processing of these colours.

Athanasopoulos et al. (2011) extended the study using adult Japanese-English bilinguals residing in the UK. English does not have separate definitions or concepts for sky blue and blue, they are both the same

colour, albeit shades apart. The Japanese language does, and the concept of sky blue is termed 'mizu iro', literally water colour, which distinguishes it from the colour blue which is called 'ao'. They gave their participants a series of light and dark blue shade pairings with 2 lightness steps and asked them to rate them for similarity. They found that the bilinguals who used English the most frequently and those that used it more so than their L1 were less likely to distinguish between the two shades of blue as being different. In essence they duplicated the behaviour of English monolinguals when doing the same test. This was in comparison to Japanese-English bilinguals who used English less frequently and also to Japanese monolinguals who distinguished the 'mizu iro' and 'ao' pairs as being different.

The Athanasopoulos et al. (2011) study was done with adults who resided in the UK and used the L2 on a regular basis and they argue that the daily usage of the L2 produced a cognitive shift to the L2 norm in how they perceived the blue stimuli. In a duplication of the research design of Athanasopoulos et al. (2011) this paper looks to see if these findings can be applied to bicultural bilingual elementary children who have been brought up since birth speaking both English and Japanese. The study here specifically looks at two sets of children, one group that resides in the UK and use Japanese as their second language and one that resides in Japan and uses English as their second language.

## Hypothesis

It is hypothesized that the bicultural bilingual children in Japan who use English (their L2) frequently will more likely not distinguish between the two shades of blue as being different in comparison to the children who use English less frequently. This would replicate the findings of Athanasopoulos et al. (2011). In contrast, the children who reside in the UK and use Japanese often will behave similarly to Japanese and make a distinction between the blue stimuli of 'mizu iro' and 'ao'. The children who use Japanese less so will not make such a distinction. Therefore a cognitive shift towards the L2 norm will occur in those bilingual children who are exposed to the L2 and use it on a frequent basis.

## The participants

In total 16 elementary and primary school pupils aged from 6 to 8 took part in this study. All are bicultural bilingual children, born to a Japanese and non-Japanese native English speaking parent. They have all been brought up bilingually since birth.

Eight of the children reside in the UK (5 boys and 3 girls). The other eight reside in Japan (4 boys and 4 girls). The sample here is from a much larger data set of participants created to look at sociolinguistic and cognitive issues in a contrastive analysis of bicultural bilingual children residing in Japan and the UK. In order to make age variables consistent the data here only looks at the cognitive processing of colour in bicultural bilingual elementary school children.

Questionnaires were given to the child's parents and based on their reports how much the children

spoke their L1 daily in comparison to their L2 was recorded. The UK based children (UKBC) spoke on average 11% of the time in Japanese and 89% of the time in their L1 (English). In contrast the Japan based children (JBC) spoke English on average 29% of the time with the remaining 71% in their first language Japanese.

Questionnaires also included background information on how the parents are raising their children to be bilingual. The native speaking parent was also asked to rate their child's L2 proficiency. Table 1 and 2 illustrate some of the findings of the questionnaire data.

Table 1 UKBC Group

Child	Language use percentages	Child's L2 proficiency
1	9% Japanese 91% English	Passive bilingual
2	9% Japanese 91% English	Passive bilingual
3	8% Japanese 92% English	Passive bilingual
4	9% Japanese 91% English	Passive bilingual
5	21% Japanese 79% English	Dominant bilingual
6	21% Japanese 79% English	Dominant bilingual
7	8% Japanese 92% English	Passive bilingual
8	7% Japanese 93% English	Passive bilingual

Table 2 JBC Group

Child	Language use percentages	Child's L2 proficiency
1	27% English 73% Japanese	Dominant bilingual
2	30% English 70% Japanese	Dominant bilingual
3	27% English 73% Japanese	Dominant bilingual
4	33% English 67% Japanese	Dominant bilingual
5	27% English 73% Japanese	Dominant bilingual
6	30% English 70% Japanese	Dominant bilingual
7	33% English 67% Japanese	Dominant bilingual
8	28% English 72% Japanese	Dominant bilingual

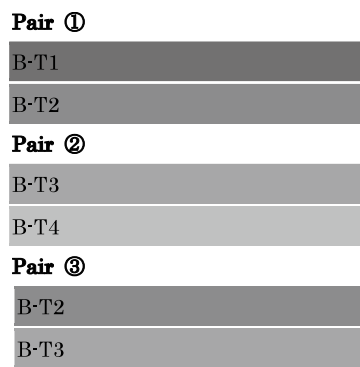
### The colour test

Replicating the Athanasopoulos et al. (2011) study 10 blue colour stimuli were selected from the Color-

Aid- Corporation (www.coloraid.com). There were 6 levels of lightness across the 10 colours or shades of blues. The colours used were classified as coming from the blue and cyan blue hue range. The Color-Aid-Corporation labels each colour according to its hue and lightness. The 10 colours used were classified as B-T1, B-T2, B-T3, B-T4, C/Hue, C/T1, C/T2, C/T3, C/T4 and C/LT. Based on the Athanasopoulos et al (2004) study the colours chosen were constantly labeled as 'ao' or 'mizu iro' by Japanese native speakers.

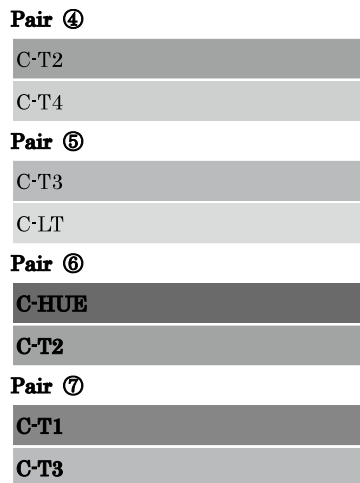
Altogether seven pairs using a combination of these colours were used in the study and are illustrated in the figures 1 and 2 below.

Figure 1. Near colours 'within category' and 'cross category' pairs



①-② are near colours with one lightness step. ③ is classified as a different colour, a cross category pair.

Figure 2. Far colours 'within category' and 'cross category' pairs



④-⑤ are near colours with one lightness step. ⑥-⑦ are classified as different colours, cross category pairs.

The pairs are placed into 'within category' and 'cross category pairs' and into near colour and far colour comparisons as illustrated in pairs 1-3 and 4-7 respectively. The within category pairs consist of colours that are either 'ao' or 'mizu iro'. Near colour pairs 1 and 2 are classified as the same colour but with one

lightness step difference. Pair 3 is classified as a different colour, that is one is 'ao' and the other is 'mizu iro'. Far colour comparisons are illustrated in pairs 4 and 5. They are the same colour but with a difference of 2 lightness steps. Pairs 6 and 7 are different colours in respect to them both being labeled as 'ao' or 'mizu iro' by Japanese native speakers.

### The colour test procedure

The pairs as illustrated above were given to each participant to judge on how different or similar they were. Each pair was presented one at a time to the child in natural daylight and viewing conditions were identical for all the children. Upon showing each pair to the child they were initially asked if the colours were similar or different. They were then asked how different or similar they were. If the child responded that the colours were similar they were additionally asked how similar? and given two options of very similar? or quite similar? and their response was recorded.

If the child answered that the colours were different they were asked how different? and given two options of completely different? or a little different? Their answers were once again recorded. The test was completed in the child's L1. Native Japanese speakers in Japan and native English speakers in the UK conducted the tests in the homes of the children. No time restrictions were given for the child's responses. To compare colour perception of the two groups a Fisher's exact test was conducted through SPSS software and the statistical level of significance was set at  $p < .05$ .

## Results

### *Test results of the near colours 'within category' and 'cross category' pairs*

Table 3 shows the results of the near colour 'within category' and 'cross category' pairs. Within each pair the UK based children (UKBC) and the Japan based children's (JBC) answers are divided into their responses per each colour pairing from 'Very similar' or 'Quite similar', and 'Completely different' or 'A little different'.

**Table 3 Near colours 'within category' and 'cross category' pairs**

	Pair 1 UKBC	Pair 1 JBC	Pair 2 UKBC	Pair 2 JBC	Pair 3 UKBC	Pair 3 JBC
Very similar	2 (25%)	0	1 (12.5%)	0	4 (50%)	1 (12.5%)
Quite similar	2 (25%)	3 (37.5%)	5 (62.5%)	6 (75%)	2 (25%)	6 (75%)
Completely different	1 (12.5%)	1 (12.5%)	1 (12.5%)	1 (12.5%)	0	1 (12.5%)
A little different	3 (37.5%)	4 (50%)	1 (12.5%)	1 (12.5%)	2 (25%)	0

Although there were differences in how the UK and Japan based children responded, a fisher exact test showed that none of the pairings proved to be statistically different in relation to how the children

distinguished the colours as being similar or different. For the same colour pairings (pair 1 and 2) with one lightness step difference the majority of both the UKBC and JBC group thought pair 1 was a little different. For pair 2 the majority of both sets of children thought the colours were quite similar

For pair 3, which is a different colour pairing with one lightness step difference; the overwhelming majority (75% with the UK based children and 87.5% with the Japan based children) thought the colours were similar and not different.

When examining just the UKBC group there were also no significant differences between them in how they perceived the pairs. This result was also duplicated when also just comparing the JBC group response data. These results showed that there were no differences in how the same colour with a difference of one lightness step was perceived. Interestingly however, the cross category pair results were also the same. These findings replicate the Athanasopoulos et al. (2011) study who also found that both Japanese and English monolinguals and their Japanese-English bilingual group did not distinguish significantly between 'within' and 'cross-category' pairs within near colour pairings.

**Test results of the far colours 'within category' and 'cross category' pairs**

Table 4 shows the results of the far colour 'within category' and 'cross category pairs'.

**Table 4 Results from the far colours within category and cross category pairs**

	Pair 4 UKBC	Pair 4 JBC	Pair 5 UKBC	Pair 5 JBC	Pair 6 UKBC	Pair 6 JBC	Pair 7 UKBC	Pair 7 JBC
Very similar	2 (25%)	0	3 (37.5%)	0	1 (12.5%)	0	3 (37.5%)	0
Quite similar	4 (50%)	0	3 (37.5%)	0	5 (62.5%)	0	3(37.5%)	0
Completely different	2 (25%)	7 (87.5%)	1(12.5%)	3 (37.5%)	1 (12.5%)	4 (50%)	1 (12.5%)	2 (25%)
A little different	0	1 (12.5%)	1 (12.5%)	5 (62.5%)	1 (12.5%)	4(50%)	1 (12.5%)	6 (75%)

For pairs 4 and 5, which are within category pairs and are the same colour separated by two lightness steps, results were significantly different. For pair 4, 75% of the UKBC group thought the colours were very to quite similar, whilst all of the JBC group thought the colours were different ( $P < 0.01$ , Fisher's exact test). For pair 5, 100% of the JBC group said the pairing was different compared to 25% of the UKBC group ( $P < 0.01$ , Fisher's exact test). The cross category pairs of 6 and 7 were also statistically different. For pair 6, all of the JBC group classified the colours as being different (completely or quite) compared to 25% of the UKBC group ( $P < 0.05$ , Fisher's exact test). Similarly all of the JBC group perceived the colours as different in pair 7 compared to 25% of the UKBC group.

Athanasopoulos et al. (2011) found that English monolinguals did not distinguish between within and

cross-category pairs in either near or far colour comparisons. The results of the UK based children parallel these findings. Similarly, findings here within the JBC group and the Athanasopoulos et al (2004) Japanese monolingual group are comparable. Both sets of data groups show that they significantly distinguished far colours, for both the 'within' and 'cross-category' pairs as being statistically different ( $P < 0.01$ ). The results here could therefore suggest that regardless of the children being exposed to a L2 (English or Japanese) and being brought up bilingually this does not seem to change their cognitive pattern in how they process and perceive these colours.

Looking at the results as a whole the majority of the UK based children judged each of the 7 colour pairings (with the exception of pair 1 which was divided equally between similar and different) as being similar. When responding, the UK based children voluntarily said that they were the same colour but different shades specifically saying that one was either light or sky blue and the other a darker blue. This was in contrast to the Japan based children, who when they responded to the far colour group pairs, asserted that the colours were different, voluntarily stating that one was 'ao' and the other 'mizu iro' in Japanese and again in English that one was blue, the other 'like a water colour' (the literal translation of 'mizu iro'). The official English translation would be 'sky blue' but this is not classified as a different colour but as a shade of blue in the English language. This would suggest that language (or the lexical names placed on these colours) greatly influences these observed cognitive effects.

### *Speaking times and responses*

It was hypothesized that based on the results of the Athanasopoulos et al. (2011) study, that the more exposure the children got in their L2, and the more frequently they use it the more likely we would see the influence of that language on how they distinguished the colour pairings. Overall based on a 14-hour day, the UKBC group spoke in Japanese, their L2, on average only 11% of the time. They also had little exposure to the L2 outside of the home in comparison to the JBC group. The JBC group spoke in their L2 29% of the time. However, what makes this data analysis different to the current studies such as the Athanasopoulos et al. (2011) research is the fact that none of the children reside in the L2 speaking country, and are children not adults.

The Athanasopoulos et al. (2011) study showed that the adult Japanese-English bilinguals residing in the UK spoke English 57% of the time on a daily basis and had an average of 38 months living in the UK. This is in sharp contrast to the amount of time both sets of children within this study speak their L2. However if we are to believe that more speaking time in the L2 may influence cognitive perception of colour you could expect the JBC group, who speak their L2 18% of the time more than the UKBC group, to behave slightly differently to both Japanese and English monolinguals, possibly being somewhere between them. However this was not the case and their responses were similar to how a Japanese monolingual would respond based on the literature (Athanasopoulos et al (2004). Therefore, it could be



suggested that if the children within this data sample spent time residing in the L2 country and spoke the target language to the extent that it exceeded their L1 output, then results here may have replicated the Athanasopoulos et al. (2011) study.

Within the cross category pairs of 6 and 7 the JBC group behaved like Japanese monolinguals with respect to them all distinguishing the colours as being different ( $P < 0.01$ , Fisher's exact test). As previously stated, most of the children labeled the colours as 'ao' and 'mizu iro' during the tests. With the UKBC group findings however, results were not so clear-cut and the answers between them were not statistically different. Pair 6 and 7 responses were divided 62.5% / 37.5% and 75% / 25% respectively with the highest percentages in favour of the colours being the same. The children that answered the 'same' suggested that they were the same colour but that one was light or sky blue and the other was a darker blue. Interestingly the two children who suggested that they were different, labeled the colours as 'ao' and 'mizu iro', explicitly stating that they were different colours, in similar fashion to the JBC group. They therefore attached lexical items to the colours rather than labeling them as being similar as the other UK based children answered. What makes these children different is that of the 8 children these 2 children reside and study in Japan for 2-3 months of the year in a Japanese elementary school. When living and studying in Japan, their English father is not present and the children therefore only speak in Japanese 100% of the time with their mother, grandparents and school friends. In addition one of the children was born in Japan and left for the UK when she was 3. Out of the 8 UK based children, these two children also speak Japanese the most on a weekly basis. According to parental reports they speak on average 21% of the time in Japanese on a weekly basis. Their Japanese mother rated them as dominant bilinguals with English being the dominant language. This was in comparison to other Japanese mothers who rated their children as passive bilinguals describing them as having the ability to understand Japanese but not being able to produce it constantly and consistently well. These proficiency factors, it could be argued, may influence their perception of these pairs and the shift it has towards the L2 norm (Japanese). Athanasopoulos's (2007) study showed that rather than length of stay and exposure to the L2, proficiency in the language was a better predictor in how and to what degree bilinguals shift towards the L2 norm. In an additional study by Athanasopoulos and Kasai (2008) these findings were duplicated. They report that cognitive preferences may shift towards the L2 in bilinguals who have never even been to the L2 country. That state that this shift occurs in advanced L2 speakers.

Within this study the children were 6-8 years old and are still under development in terms of cognitive abilities. The relationship between language and cognition in child development is a hotly debated notion within the social sciences. The cyclical relationship of language and cognition is the essence of the Linguistic relativity hypothesis. Lucy and Gaskins (2001, 2003) write that language specific influence on general cognition first appears in children around the age of eight. However, Lucy (2015) states that what happens in terms of linguistic relativity when children acquire two languages simultaneously (as

represented within this study) is largely unknown. He concedes that more research is required in this area.

## Conclusion

This paper aimed to replicate the Athanasopoulos et al. (2011) study but instead of the participants being Japanese-English speaking adults residing in the UK the participants were bilingual bicultural children who live in the country of their birth, the L1 country. It was hypothesized that despite not living in the L2 country, the fact that they have been brought up bilingually with two languages could have a bearing on how they perceive perceptual distances of colour. Based on L2 speaking times, it was furthermore hypothesized that within the JBC group we would see a cognitive shift in how the children perceive the colour pairings in comparison to monolingual Japanese speakers. As the speaking times of the UKBC group were much lower it was expected that there would not be a significant change in how they and English monolinguals perceive the colour pairings.

Results showed that despite both groups being brought up bilingually there was no cognitive shift in how the children processed the blue stimuli. This is probably due to the fact that the children's L2 speaking frequency did not exceed their L1 speaking times, a situation you would expect for children growing up and being schooled in the L1 country. It is therefore argued that to produce similar results to the Athanasopoulos et al. (2011) study and for there to be a cognitive shift in colour processing and perception the children would have to be residing in or have lived in the L2 country for a period that exceed a typical 2 week holiday. This was confirmed with the results of 2 children from the UKBC group who are schooled in Japan for a 2-3 month period every year and use their L2 more than their L1. The fact that one of them was born in Japan and lived there until she was 3 is also an influential factor. Similar results were not duplicated in the JBC group, probably as a result of the children within this group not living in the L2 country for extended periods.

This study is based on a small study sample and the children's L2 proficiency was not tested as there is no standard test that could be used across the Japanese and English languages to determine similar level. The study also refers to the previous findings of how adult Japanese and English monolinguals responded to the colour perception test. It would therefore be interesting to see how British and Japanese children would respond if given the same test.

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