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The effect of form similarity on bilingual children's lexical development*

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Previous studies of adult bilinguals have shown that cognates (translation equivalents similar in sound and spelling) are translated faster than non-cognates and different representations for the two categories in bilingual memory have been suggested (Kroll and Stewart 1994, van Hell and de Groot 1998). Assuming that bilingual children's representations are similar to those of adults, effects of form similarity between words should also be observed. This paper examines form-similar nouns in the early lexical development of a bilingual German/English child aged 1;11–2;9 as well as effects of form similarity in picture naming and translation in two groups of German/English children aged 8–9. Form similarity here differs from the cognate status of a word in that it implies similarity of sound only. Considering the way hearing children acquire words, it seemed necessary to restrict the similarity of words to this modality. Similarly, the presentation of items in the translation tasks was auditory. The results show an effect of form similarity in early lexical development, whereby form-similar words occurred frequently in the beginning of the observation period in both languages and were more likely to have a translation equivalent in the child's English. In the translation task, form similarity resulted in lower latencies for both language directions. The results thereby confirm that form similarity affects representations in both adult and child learners.

Introduction

Recent bilingual first language acquisition research concerned with the representation of the simultaneously acquired languages in children has provided evidence in favour of a separation of the two languages from very early on (Meisel, 1989; de Houwer, 1990; Gawlitzek-Maiwald and Tracy, 1996; Paradis and Genesee, 1996; Sinka and Schelletter, 1998).

While most of these studies have focused on the child's acquisition of morphosyntax, there is also some evidence for this view based on the occurrence of cross-language synonyms in a bilingual child's early lexicon (Pearson, Fernández and Oller, 1995; Quay, 1995). The occurrence of such "doublets" in early lexical development is not in line with Clark's principle of contrast (1987), which suggests that the child does not accept synonyms at this stage. Based on this principle, Volterra and Taeschner (1978) suggested an initially "fused" system that would reject cross-language synonyms.

Another argument for a fused system was based on the occurrence of "mixes", which are utterances where the child uses lexical items from both languages in a particular language context (Lanza, 1997). Other studies have re-interpreted these language forms as the "borrowing" of a word that the child has encountered in a different language context (Paradis and Genesee, 1996).

Given the evidence in favour of an early separation of the two languages of a bilingual child, the present paper aims to move on from the discussion about the Single System versus Separate Development hypothesis and investigate in more detail how the child builds up language representations for the two language systems and which factors facilitate the development of such representations.

In an analysis of two bilingual children's lexical development, Sinka, Garman and Schelletter (2000) and Schelletter, Sinka and Garman (2001) adopted a lexical profiling approach to examine the children's expanding noun and verb vocabulary for each language. They found that lexical vocabulary builds up independently in the languages of the children studied. There was a discrepancy between the two lexical categories, showing that verbs are much more

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tied in with grammar, whereas nouns vary according to situational context. In addition, one of the children studied, who was acquiring English and German, was found to have nouns occupying high frequency ranks in both languages that are similar in form to their respective translation equivalents in the other language.

Given the historical relationship between English and German, this finding is not surprising. However, the question is whether this is simply an accidental property due to the language similarities or whether a child who is acquiring such a combination of languages actually makes use of form similarity to build up language representations.

Form similarity between lexical items has indeed been shown to be an important factor in conceptual memory organisation in adult second language learners. Translation pairs that are similar in form and meaning, so-called cognates, have been shown to be translated faster by adults in translation tasks involving English and Dutch (Kroll and Stewart, 1994; Kroll and de Groot, 1997; van Hell and de Groot, 1998).

In order to account for these findings, a feature overlap in the conceptual representations for words in the two languages of a bilingual has been suggested (Conceptual Feature Model, Kroll and de Groot, 1997; van Hell and de Groot, 1998). This overlap varies and is assumed to be greater for cognates than for non-cognates. By assuming a difference in the amount of overlap, the model can account for word-type effects in translation, such that cognates are translated faster than non-cognates and similarly, concrete words are translated faster than abstract words.

The present investigation uses the term ''form similarity'' rather than ''cognate status'' for two reasons. In the original sense of the word, cognates describe a linguistic form that is historically related to the same word in another language. Such a relationship might not exist for all ''form-similar'' pairs and where it does exist, there might be meaning differences between the words, which could be misleading. Then there is the question whether the historical connection is always transparent to the learner, particularly where the linguistic forms are quite far apart.

Secondly, as Dijkstra, Grainger and van Heuven (1999) point out, the effect of the cognate status of words in translation tasks is based primarily on similarities of the written form across languages (interlingual homography), as this is how words are presented. However, this means that cognates can differ in the amount of phonological overlap they have.

In the context of the present study, however, phonological similarity is crucial, given that hearing children learn words through the auditory channel and therefore only have phonological representations of words before school age. Therefore, if form similarity plays a role in bilingual lexical development, this must be based on the phonological similarity between translation equivalents (interlingual homophony). Form similarity in the present context therefore describes word pairs that are similar in meaning as well as their phonological form.

Regarding bilingual children's lexical and conceptual representations, it is not clear whether these are comparable to those of adults, given that children need to form concepts as well as lexical representations in both languages, whereas adult second language learners already have the concepts and first language representations in place. Nevertheless, children's mental representations can be assumed to ''eventually develop in conformity with the adult model'' (Bialystok, 2001, p. 104), therefore it is conceivable that effects of form similarity, that were found in adults, can also be observed in children.

The present study draws on two types of evidence to examine the role of form similarity in the early lexical development of bilingual children. Firstly, the nouns observed in spontaneous conversation in the English/German subject of the Schelletter et al. (2001) study were grouped according to form similarity and the occurrence of translation equivalents for each noun group was compared. If form similarity is more than an accidental property at this stage, it could facilitate the forming of cross-language synonyms.

The second type of evidence comes from a picture naming and translation task that was carried out with two groups of German/English bilingual children and a group of adults to see whether form similarity effects can also be found in children with different length of exposure to another language.

Experimental data of this type, that include children and adults, are rare so far. There is only one such study, by Chen and Leung (1989), which compares reaction times for picture naming and translation as well as for language directions for native Cantonese speakers with different levels of proficiency in English. Effects of form similarity were not investigated. Given that Cantonese and English are languages belonging to quite different language families, the amount of form similarity between words in Chinese and their translation equivalents in English can be assumed to be minimal. In contrast, the languages under investigation in the present study have a common root in that they are both Germanic languages. Chen and Leung's (1989) results are in line with previous findings in that there was an effect of language, such that naming and translation into the non-native language (L2) takes longer than into the native language (L1),

Table 1. *Noun types and tokens during the observation period*

	1;11–2;3		*2;4–2;6*		*2;7–2;9*		*Total*	
	Types	Tokens	Types	Tokens	Types	Tokens	Types	Tokens
German context								
German	67	289	58	162	14	36	139	487
Noun TTR	0.23		0.36		0.39		0.29	
English	3	18	1	1			4	19
English context								
English	34	82	12	27	37	125	83	234
Noun TTR	0.41		0.44		0.3		0.35	
German	3	3	1	5	1	1	5	9
Total	107	392	72	195	52	162	231	749

and also of task, such that picture naming takes longer than translation.

The Revised Hierarchical model (Kroll and Stewart, 1994) accounts for these findings in that it allows for lexical links between the two languages of a bilingual as well as links from the lexical level of each language to the conceptual level. These links can vary in strength, such that a less proficient speaker of a second language will have weaker lexical links from L1 to L2 than from L2 to L1 and also weaker links between the conceptual level and L2 than between the conceptual level and L1.

These weaker links account for the higher latencies for naming and translation into L2. In addition, the faster translation latencies in contrast to naming can be explained by assuming translation to involve word-to-word association without any involvement of the conceptual level, whereas picture naming requires an activation of the conceptual level.

However, Chen and Leung found an asymmetry between adults and children, whereby translation into L2 was faster than picture naming for less fluent adults but slower for less fluent children. It is suggested that children might not be as efficient in establishing lexical links between L1 and L2, compared to adult second language learners. If this is the case, child second language learners can be expected to have higher translation latencies than adults, at least for translation into L2.

The aim of the present study is to establish whether form similarity has an effect on the developing bilingual representations both at an early stage of language acquisition as well as at a later stage, where a number of representations are already established. Given the results on cognates in adult second language learners, effects of form similarity are expected to hold for fluent bilingual adults and children.

Bilingual case study

Method

One female German/English bilingual child was observed from the age of 1;11 to 2;8 in German and 2;2 to 2;9 in English. Her language developed relatively late: at the beginning of the observation period, she was starting to put two words together. Spontaneous language samples were recorded fortnightly for about 45 minutes per session. No English samples were recorded at 2;4 and 2;5. The parents followed the ''one person one language principle'' (Ronjat, 1913). The father is a native English speaker and provided the English input, the mother is a native German speaker. The child has an older sister who is fluent in both languages. Input in both languages was judged by both parents to be about equal. An investigation of her early language development shows that she was ahead in German as far as her morphosyntactic development was concerned (Sinka and Schelletter, 1998).

Results

The child's early use of lexical nouns in both languages is investigated in transcript cuts of 250 words in the observation period. Of the nouns occurring in the transcript cuts, only count nouns and mass nouns are selected. Proper names were excluded from the analysis. The nouns are further divided into those that are form-similar across the two languages and those that are not. In order for a noun to be classed

Table 2. *Translation equivalents by form similarity*

	Translation Equivalent				*Total*		*Noun TTR*
	Observed		Not observed				
	Types	Tokens	Types	Tokens	Types	Tokens	
German context							
Form identical	6	80	3	41	9	121	0.07
Form similar	14	59	28	76	42	135	0.31
Form dissimilar	17	81	45	151	62	232	0.27
English context							
Form identical	6	56	0	0	6	56	0.11
Form similar	15	46	13	31	28	77	0.36
Form dissimilar	17	34	22	67	39	101	0.39
Total	75	356	111	366	186	722	

as form-similar, a criterion is adopted that requires 50% or more of the phonemes making up the noun and its translation equivalent to be similar. Form similarity implies that consonants share at least two of the three-way label (place of articulation, manner of articulation, voiced/voiceless) and vowels differ minimally within the vowel classification. The order of phonemes within the word is also taken into consideration. Table 1 gives an overview of the noun types and tokens used across the observation period for each language context. They also list nouns that are included from the other language (mixes).

Overall, there are 231 noun types and 749 tokens in both language contexts. Both types and tokens are higher in the German context (143 types and 506 tokens) as opposed to the English context (88 types and 243 tokens) since sampling was less continuous in the latter context. However, the overall type-token ratio for language appropriate responses (0.29 for German and 0.35 for English) is fairly similar. The table also shows that language inappropriate responses (language mixes) mainly occur at the beginning of the observation period and decrease with increasing language competence.

In order to assess the influence of form similarity across languages on the deployment of nouns and their translation equivalents, nouns were grouped into three categories of form similarity: identical, similar and dissimilar. Form-identical nouns do not differ in their phonological form across the languages and are mainly constituted of anglicisms, such as *teddy*, *baby*, *buggy* or international words such as *pizza*. Form-similar nouns were those judged by a linguist with knowledge of both languages to have at least 50% similar phonemes but are phonetically distinguishable. Nouns falling into this category are, for example, *book–Buch*, *apple–Apfel*, *nose–Nase*, *bed–Bett* and *boat–Boot*. Form-dissimilar nouns share less than 50% of their phonemes with the translation equivalent in German. Examples are *boy–Junge*, *tree–Baum*, *biscuit–Keks*, *head–Kopf* and *chair–Stuhl*. Table 2 gives the types and tokens for each category of nouns according to the presence or absence of translation equivalents within the data investigated here.

The table shows that for both language contexts, form-identical nouns are restricted in the number of types (9 overall) but are used quite frequently. As a result, noun type-token ratios are quite low (0.07 for German and 0.11 for English). Six out of nine types occur in both languages and the lexical items are identical. For English, all noun types and tokens in this class have observed equivalents in German (100%), whereas for the nouns used in the German context, the rate is 67%.

Form-similar nouns make up 38% of all the noun types in both languages and 29% of the tokens. For the German context, translation equivalents are observed for 14 out of 42 types (33%), whereas in English it is 15 out of 28 types (54%). For one noun, "wasp", both translation equivalents occurred in the English context only. This difference between languages was also prevalent in the tokens of similar nouns with observed translation equivalents: for German, this is 59 out of 135 (44%), whereas for English it is 46 out of 77, which is 60%.

Form-dissimilar nouns are the largest group and make up 54% of all noun types in both languages and 46% of all the tokens. Translation equivalents are

Table 3a. *Frequency of form-similar nouns with observed translation equivalents*

	1;11	*2;0*	*2;1*	*2;2*	*2;3*	*2;4*	*2;5*	*2;6*	*2;7*	*2;8*	*2;2*	*2;3*	*2;6*	*2;7*	*2;8*	*2;9*	*Total*
Form-	German context										English context						
similar	Tokens: 59 Ger, 5 Eng										Tokens: 46 Eng, 6 Ger					**116**	
Ball	–	–	–	–	–	1	–	–	–	–	3	–	1	–	–	–	5
Ball	–	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	3
Bed	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	–	5
Bett	12	–	–	2	5	–	2	4	4	–	–	–	–	1	–	–	30
Bean	–	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	5
Bohne	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Book	2	–	–	1	–	–	–	–	–	–	4	–	–	–	–	–	7
Buch	–	–	3	2	1	–	1	–	–	–	–	–	–	–	–	–	7
Cassette	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1	2
Kassette	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Cat	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	4
Kätzchen	–	–	–	–	2	2	–	–	–	–	–	–	–	–	–	–	4
Chocolate	–	–	–	–	–	–	–	–	–	–	–	–	3	–	–	–	3
Schokolade	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	2
Hand	–	–	–	–	–	–	–	–	–	–	–	1	–	2	1	–	4
Hand	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Icecream	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2	4
Eis	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Milk	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Milch	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Moon	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	2
Mond	–	–	3	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Shoe	–	–	–	1	–	–	–	–	–	–	–	4	–	–	–	–	5
Schuh	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
Snow	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Schnee	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Thing	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Ding	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	1
Wasp	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	2
Wespe	–	–	–	–	–	–	–	–	–	–	–	–	5	–	–	–	5

observed for 17 out of 62 types for German (27%) and 17 out of 39 types for English (44%). The proportion of tokens with observed translation equivalents is similar across the languages: 81 out of 232 for German (35%) and 34 out of 101 for English (34%).

Comparing form-similar and form-dissimilar nouns in relation to observed translation equivalents, it seems that language equivalents occur for a larger proportion of form-similar noun tokens than dissimilar noun tokens, particularly in English, where this difference is 26%, but also in German, where it is 9%. Fisher's exact tests were performed for both language contexts. For German, the p-value for a one-tailed test is close to being significant ($p = 0.54$), whereas for English, the result for a one-tailed test is highly significant: $p < 0.001$.

In order to further assess the child's strategy in building up translation equivalents for the two languages, Tables 3a and 3b list phonetically similar and dissimilar lexical nouns with documented translation equivalents within the period of observation. Shaded grey cells show occasions where an item has been used in the other language context (mixes).

Tables 3a and 3b show that there are 15 form-similar and 17 form-dissimilar nouns for which translation equivalents were observed. The most frequent item in the list of form-similar nouns is the item *bed–Bett* which differs between the languages in terms of the length of the vowel (it is a short vowel in German) as well as the voicing of the final consonant. The item is first established in German at 1;11 and the translation equivalent occurs in English at 2;3. Out of 35 occurrences of this item in the observation period there is only one occurrence of the German equivalent in the English context. For dissimilar nouns, the most frequent item is *boy–Junge*. This

Table 3b. *Frequency of form-dissimilar nouns with observed translation equivalents*

	1;11	*2;0*	*2;1*	*2;2*	*2;3*	*2;4*	*2;5*	*2;6*	*2;7*	*2;8*	*2;2*	*2;3*	*2;6*	*2;7*	*2;8*	*2;9*	*Total*
Form-dissimilar	German context Tokens: 81 Ger										English context Tokens: 34 Eng, 3 Ger						**118**
Birthday	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Geburtstag	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Biscuit	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	2
Keks	–	–	9	–	–	–	–	–	–	–	1	–	–	–	–	–	10
Boy	–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	4
Junge	–	–	1	2	7	–	1	–	4	–	1	–	–	–	–	–	16
Cake	–	–	–	–	–	–	–	–	–	–	1	1	–	–	–	–	2
Kuchen	–	–	1	–	–	1	–	2	–	–	–	–	–	–	–	–	4
Chair	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	3
Stuhl	–	–	–	–	2	–	–	1	–	–	–	–	–	–	–	–	3
Crayon	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Stift	–	–	–	–	–	8	–	–	–	–	–	–	–	–	–	–	8
Cup	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Tasse	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	1
Dice	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1
Würfel	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	2
Doggy	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2
Wauwau	–	–	–	2	–	1	–	–	–	–	1	–	–	–	–	–	4
Duck	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1
Ente	–	–	–	–	4	1	–	–	–	–	–	–	–	–	–	–	5
Egg	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	2
Ei	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1
Food	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
Essen	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	1
Girl	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Mädchen	–	–	–	1	–	5	–	–	–	–	–	–	–	–	–	–	6
Hat	–	–	–	–	–	–	–	–	–	–	1	–	–	–	2	3	6
Mütze	–	–	2	–	–	–	–	–	–	4	–	–	–	–	–	–	6
Plate	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	2
Teller	–	2	–	1	3	–	–	1	2	–	–	–	–	–	–	–	9
Rabbit	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	2
Häschen	–	–	–	–	–	–	4	2	–	–	–	–	–	–	–	–	6
Swing	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Schaukel	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1

word occurs first in German at 2;1 and is observed in English at 2;7. Prior to the use of the translation equivalent, there is one occurrence of the German equivalent in the English context at 2;2.

Overall, form-similar and dissimilar nouns differ in their token frequency across languages. For form-similar nouns, there are 59 German tokens and 5 English tokens in the German context. In the English context there are 46 English token and 6 German tokens. While 8 out of 15 translation pairs first emerge in German, 4 items are first observed in English and for 3 nouns both translation equivalents occur at the same age. On average, the translation equivalent of a form-similar noun occurs 2.7 months after the first emergence in the other language context.

In contrast, for form-dissimilar nouns, there are far more tokens in the German context (81 German and no English tokens) than in the English context (34 English tokens and 3 German tokens). Also, 13 out of 17 types first emerge in German. On average, the translation equivalent of a form-dissimilar noun occurs 3.6 months after this form first emerged in the other language context.

These results show that while the child's vocabulary is diversifying more in German than in English during the period of observation, her use of translation equivalents is far more balanced across languages for nouns that are form-similar than for dissimilar nouns and the gap between the occurrence of both translation equivalents is smaller for form-similar items.

The results of this investigation into the role of form similarity on the child's early bilingual lexical development have shown that where there is a degree of form similarity across languages, this is facilitating the child's lexical development, particularly in the early stages. While translation equivalents are observed for both similar and dissimilar nouns within the observation period, it seems that form similarity is linked to frequency of use. Words that are form identical across languages have the highest token frequency and for form-similar nouns, a higher proportion of tokens was observed in both language forms.

Picture naming and translation tasks

Subjects

The study included 16 children from a European school in the UK as well as 12 German adults resident in the UK. The children all attended year 3 of the German section of the school at the time of testing and were aged between 8 and 9. There were eight girls and eight boys. All children came from a middle class background. Their classroom language was mainly German but the children also attended English language classes and took part in sports and crafts activities together with non-German speaking children as part of the curriculum. Other contact with English speakers and non-German speakers were on the school playground, but also when speaking to non-German teachers and other staff (secretary, canteen staff, caretaker).

The children were subdivided into two groups of eight subjects. Those in the first group all had more prolonged contact with the English language, either through a mixed German/English home background or through English institutions (nursery, primary school) prior to the European school. Those in the second group all came from a German monolingual home background and did not attend English institutions. Although the length of time they had stayed in Britain varied from 6 months to 4 years, the children's fluency varied more according to the amount of contact they had with English monolingual peers (such as neighbours).

The adults were between 21 and 54 years old. They all grew up as German monolingual speakers and learned English as a second language at school, prior to living in England. They were all from a middle class background. Although the amount of time the subjects had spent in Britain varied, all subjects used German on a daily basis with their partner, their children, in teaching or by interacting with colleagues and friends.

Method

Children were tested at school in a classroom adjacent to their own. Adults were tested at home or at their workplace. All subjects were seen individually for about 5–10 minutes. The materials used consisted of 40 coloured clipart pictures of familiar objects, 20 for each language, as well as 40 words describing familiar objects, again 20 for each language. The objects depicted or named overlap with the Snodgrass and Vanderwart set (Snodgrass and Vanderwart, 1980) and include different semantic categories, such as animal names, body parts, food or drink, household objects, clothes and outdoor objects (buildings, playground equipment, plants). All items are concrete nouns that should be familiar to children of the included age group.

The items were matched for word familiarity and word frequency. The latter is based on written word frequencies of the LOB Corpus for English (Johansson and Hofland, 1989) and a corpus held by the Institut für Deutsche Sprache, Mannheim, Germany, for German (Institut für Deutsche Sprache, 1998). In order to ensure comparability, frequency ratings were derived for all nouns in both languages. Familiarity ratings and age of acquisition ratings were taken from Masterton and Druks (1998) and Morrison, Chappell and Ellis (1997) for English nouns and also the English translation equivalents of German nouns. In order to allow for the possibility that familiarity ratings differ between children and adults, a different child familiarity rating was also included (Cycowicz, Friedmann, Rothstein and Snodgrass, 1997). In addition, nouns were grouped into form-similar and form-dissimilar. This decision was based on a comparison between the phonological similarity of each of the phonemes of a word and its translation equivalent. The same criterion was applied as in the first study, namely, that nouns were classed as form-similar if at least 50% of phonemes were similar and form-dissimilar otherwise.

The procedure included four tasks in total, two picture naming tasks and two translation tasks. Five training items were used initially for each task. Picture naming always preceded translation but the order of the tasks within these sets was randomised. For all tasks, children were told beforehand which language to respond in. While pictures were presented for the naming task, the stimulus for the translation task was auditory. This was because not all the subjects were familiar with written English words at this stage and this could have influenced their reaction times.

Table 4. *Picture naming: reaction times in ms, accuracy and differences for all groups**

Picture Naming (Accuracy)	*Bilingual Children N = 8*	*Less Fluent Children N = 8*	*Difference Children*	*Fluent Adults N = 12*	*Difference Adults–Children*
L1	1200 (.99)	1217 (1)	17	1026 (1)	182.5
(SD)	(655)	(716)		(637)	
L2	1278 (.98)	1357 (.85)	79	1132 (.99)	185.5
(SD)	(781)	(816)		(775)	
Language Difference	78	140		106	

* L1 is German and L2 is English in the table above. The data are based on 315 out of 320 observations for the bilingual children, 294 out of 320 observations for the less fluent children, and 476 out of 480 observations for the adults.

Table 5. *Translation: reaction times in ms, accuracy and differences for all groups**

Translation (Accuracy)	*Bilingual Children N = 8*	*Less Fluent Children N = 8*	*Difference Children*	*Fluent Adults N = 12*	*Difference Adult–Children*
L2 to L1	1597 (.99)	1480 (.89)	−117	661 (.99)	877.5
(SD)	(1360)	(1171)		(512)	
L1 to L2	1642 (.93)	1624 (.72)	−18	663 (.96)	970.5
(SD)	(1251)	(1512)		(695)	
Language Difference	45	144		2	

* L1 is German and L2 is English in the table above. The data are based on 299 out of 320 observations for the bilingual children, 244 out of 320 observations for the less fluent children and 454 out of 480 observations for the adults.

A list of all pictures and words used in the tasks is given in the Appendix, together with ratings for familiarity, frequency, form similarity and age of acquisition where this was available.

The subjects were video-recorded during the tasks and reaction times were measured subsequently using a frame-by-frame analysis where one frame had a duration of 40 milliseconds. While this method obviously gave less accurate reaction time measurements, it overcame some of the problems that the use of a microphone or button box in conjunction with a computer programme could have. These devices stop measuring reaction times when any sound is made, even when this is not the target word but, for example, when the subject accidentally makes a noise, coughs or starts giving a non-target word which is subsequently corrected. Particularly when children are used as subjects, there is a greater risk that the technical equipment is too sensitive and measurements are lost. An ideal way of testing perhaps would have been to use the computer equipment and the video as a backup.

Results

Mean reaction times in milliseconds (ms) were derived for all groups and for all tasks. For picture naming, the reaction times were measured from the point where the picture was turned over to the point where the subject started responding. For translation, the reaction time was measured from the end of the experimenter's articulation of the word to the onset of the subject's response. No responses and error responses were omitted from the reaction time analysis.

Due to a number of very high reaction time measurements, scores of over 7000 ms were also excluded from the analysis and the means calculated on the remaining latency measurements. It was found that the dependent variable "reaction time measurement" was not normally distributed and a log transformation was performed in order to be able to apply parametric test procedures.

Table 4 shows that the mean reaction times for the picture naming task were lower for L1 for all

Table 6. *Picture naming: reaction times for form-similar and form-dissimilar items**

Picture Naming	*Bilingual Children N = 8*	*Less Fluent Children N = 8*	*Difference Children*	*Fluent Adults N = 12*	*Difference Adult–Children*
L1 Form similar	1073	1099	26	854	232
(SD)	(536)	(493)		(447)	
Form dissimilar	1405	1221	−184	1000	313
(SD)	(1036)	(518)		(508)	
L2 Form similar	1058	1111	53	1088	−3.5
(SD)	(469)	(402)		(647)	
Form dissimilar	1168	1257	89	951	261.5
(SD)	(596)	(558)		(393)	
Difference					
L1	332	122		146	
L2	110	146		−137	

* L1 is German and L2 is English in the table above. The data are based on 127 out of 128 observations for the bilignual children, 121 out of 128 observations for the less fluent children, and 187 out of 192 observations for the adults.

groups and the accuracy scores were highest. The language difference was highest for the less fluent children (140 ms) and lowest for the bilingual children (78 ms). As Table 4 shows, the bilingual children were faster naming pictures in L2 compared to the less fluent child group and they were also more accurate. There was also a latency difference between adults and children of about 180 ms for both languages.

Regarding translation, both child groups had significantly higher latencies for both languages than the adults (about 900 ms; cf. Table 5). Again, there was a language difference that was more pronounced in the less fluent child group as opposed to the bilinguals. However, it seems that the less fluent child group was faster at translation than the bilingual group, though less accurate in both directions. For the child groups, there was a higher latency variation, compared to the picture naming task.

Overall, there was a significant difference between the groups in terms of accuracy. A one-way ANOVA shows that $F(2,2237) = 62.38$, $p < 0.001$. A two-way ANOVA, including group and task type as factors shows that both group and task type are significant single factors and the interaction between group and task type is also significant. $F(2,2076) = 200.33$, $p < 0.001$ for group as a factor and $F(1,2076) = 25.8$, $p < 0.001$ for task type. Pairwise comparisons of the variable "group" show that the adults were significantly faster than both child groups.

In order to investigate the effect of form similarity on subjects' performance, the reaction times of eight similar and eight dissimilar picture naming and translation items were compared. The items were matched by frequency. For picture naming, the mean frequencies of similar and non-similar items were 281 and 318, respectively. For translation, the mean frequencies were 1373 and 1237. Tables 6 and 7 present the reaction times for form-similar and dissimilar items in the picture naming and translation tasks.

Table 6 shows that there was a slight effect of form similarity for both child groups and for both language directions. The difference was most pronounced for the bilingual children's naming in German, whereas no effect was found for adults' naming in English. Overall, the difference in picture naming latency between adults and children was preserved, except for picture naming of form-similar items in English where the latencies of all three groups were very close.

Table 7 shows that there was an effect of form similarity on translation for all groups and both language directions. However, the latency difference was greater for L2 (English) for all groups, particularly for the less fluent child group.

A two-way ANOVA including form similarity and tasktype as factors was carried out for each group of subjects. For the group of adults, both form similarity and tasktype are significant single factors: $F(1,369) = 25.8$, $p < 0.001$ for form similarity and $F(1,369) = 168.5$, $p < 0.001$ for tasktype. The inter-

Table 7. *Translation: reaction times for form-similar and form-dissimilar items**

Translation	*Bilingual Children N = 8*	*Less Fluent Children N = 8*	*Difference Children*	*Fluent Adults N = 12*	*Difference Adult–Children*
L2 to L1					
Form similar	1251	908	−343	399	680.5
(SD)	(1340)	(454)		(194)	
Form dissimilar	1454	1331	−123	683	709.5
(SD)	(1038)	(1039)		(574)	
L1 to L2					
Form similar	1133	1128	−5	386	744.5
(SD)	(1061)	(749)		(281)	
Form dissimilar	1990	2245	255	787	
(SD)	(1298)	(2211)		(793)	
Difference					
L1	203	423		284	
L2	857	1117		401	

* L1 is German and L2 is English in the table above. The data are based on 123 out of 128 observations for the bilingual children, 113 out of 128 observations for the less fluent children, and 186 out of 192 observations for the adults.

action between form similarity and tasktype is also significant: $F(1,369) = 23.1$, $p < 0.001$. Figures 1–3 give the mean reaction times for form-similar and dissimilar item for each tasktype for all three groups.

Figure 1 shows that form-similar items were translated faster by the adults, yet there was no such effect for picture naming for this group.

For the bilingual children, there was a significant effect of form similarity only. $F(1,246) = 13.4$, $p < 0.001$. Figure 2 shows that for both tasks, picture naming and translation, form-similar items had lower latencies.

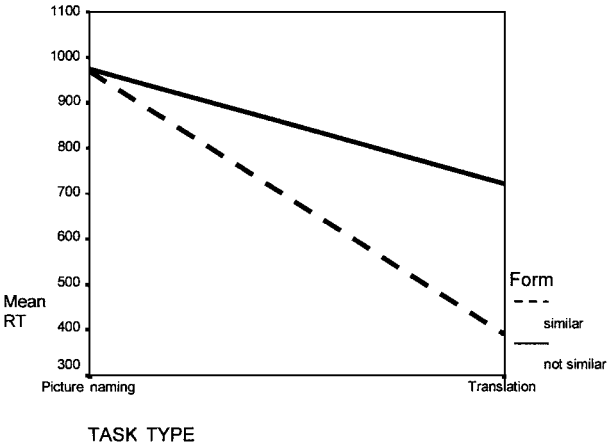

Figure 1. Mean reaction times for form similar and dissimilar items, adults.

For the less fluent children, Figure 3 shows that their result was similar to that of the group of bilinguals. Again, there was a significant effect of form similarity only: $F(1,230) = 7.01$, $p < 0.01$.

To summarise, the findings from the picture naming and translation tasks with fluent bilingual adults and children show a slight language asymmetry in all of the groups and for both tasks. Adults were faster in translation than picture naming, whereas children's latencies for both tasks were at a similar level. Adults were significantly faster than

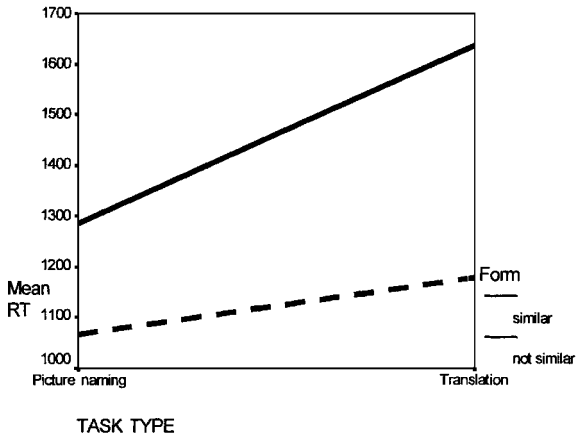

Figure 2. Mean reaction times for form similar and dissimilar items, bilingual children.

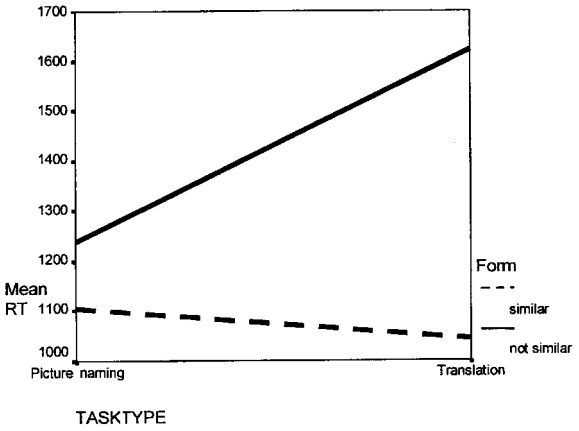

Figure 3. Mean reaction times for form similar and dissimilar items, less fluent group of children.

children in both tasks, but the difference was more dramatic in the translation task. Form similarity was found to facilitate translation in all groups, yet there was a slight effect in children's picture naming as well.

Discussion

Regarding the mapping of lexical representations to concepts, the results for the adults support the view that picture naming is conceptually mediated whereas translation is mediated lexically in both directions. At the same time, no significant language asymmetry in the translation task was found, and neither was there a difference in the effect of form similarity on translation latencies across languages. This suggests that translation in both language directions is mediated in the same way.

This result is different from previous findings (Kroll and Stewart 1994), which suggest that translation from L2 to L1 only is mediated lexically. In their study, Kroll and Stewart found translation latencies from L1 into L2 to be higher than latencies from L2 to L1 for both cognates and non-cognates (the mean difference between translation directions was 94 ms for cognates and 41ms for non-cognates). In addition, reaction times for translation from L1 to L2 increased for categorised lists (the mean difference between translation directions was 212 ms for cognates and 168 ms for non-cognates). One difference between the present study and that by Kroll and Stewart is that the adults tested here all lived in the country where L2 (English) is spoken. This could have affected the way they were mediating the translation direction from L1 to L2.

The strongest finding in this study is the difference in translation latencies between children and adults. These occurred in both directions and for the children they were at a similar level to the picture naming latencies. Given that the difference between children and adults in the translation tasks was much greater than in the picture naming tasks and occurred more consistently across even the fastest items for the children, this suggests that there is a difference between children and adults in the way translation is mediated.

Regarding the bilingual children, it seems plausible to assume that they mediate both tasks conceptually, whereas the adults are able to make use of word-to-word associations. Further evidence for conceptual mediation comes from semantic errors in the children's translations, such as *feet* for *leg*, *sheep* for *goat, seesaw* for *swing* or *spoon* for *knife.* Such errors occurred more often in translations from German into English and were far less frequent in the adult group.

The group of less fluent children had similar latencies to those of the bilingual children. However, the children in this group learnt a second language after a first language was clearly established. For adult second language learners, the Revised Hierarchical model (Kroll and Stewart 1994) allows for a shift from lexical mediation from L1 to L2 initially to conceptual mediation with increasing fluency. Such a shift was supported by the findings by Talamas, Kroll and Dufour (1999) based on a task involving false translation pairs. They found that less fluent student learners relied more heavily on information about word form, whereas more fluent learners were able to access meaning directly.

Although no difference in the mean latencies for the translation task was found between the two child groups in the present study, latency variations between individual children in this group in particular could indicate a difference in the way translation is mediated by different children.

On the other hand, the difference in latencies between adults and children could be due to the fact that children might be less efficient in establishing lexical links between items and translation equivalents, as suggested by Chen and Leung (1989). In the case of the children included here, an important factor is that the subjects learned the language in a naturalistic rather than structured way. It would be useful in this context to compare children who had formal language instruction only with those who learned the language in the country itself, as is the case here.

Form similarity was also found to have a slight, though not significant effect on children's picture naming latencies. This finding is supported by the occurrence of a number of the errors that are semantic–phonetic in nature, whereby a similar

semantic category was named that has a translation equivalent with a high degree of phonological similarity. Examples from the data are *horse, cloud* and *lion* which were named as *foal* (German: *Fohlen*), *wind* (German: *Wind*) and *tiger* (German: *Tiger*), respectively. Such errors hardly occurred in the adult group and raise the question to what extent the other language is involved for the children when engaged in the picture naming task.

General Discussion

The present study set out to look at the effect of form similarity in the longitudinal data of a bilingual German/English child and also in the reaction time data of two groups of fluent bilingual German/English children and a group of adults.

Form similarity was found to have an effect in both types of evidence considered here. The observed word-type effects in school age children suggest different representations for form-similar and dissimilar words along the same lines as previously found for adults. However, the finding that form similarity also plays a role at the beginning of lexical development raises the possibility that the child makes use of form similarity to build form–meaning mappings in both languages.

A child learning two languages from the onset will need to distinguish between words that can be used in both language contexts, such as names and form-identical words, and words that differ in form across languages. For the former group, only one cross-language representation is needed. Form-identical words were found to occur frequently in the early child data.

Form-similar words differ minimally in their sound structure across the languages. For these word pairs, a feature overlap in the conceptual representations is suggested for adult learners. It seems from the evidence presented here that form similarity might well facilitate the establishment of such a representation, given that translation equivalents were found to occur for a larger proportion of form-similar noun tokens and the lag between the use of a noun and its translation equivalent was smaller for similar than dissimilar nouns.

Form-dissimilar nouns differ in their sound structure and no feature overlap is assumed. However, given that form similarity is a matter of degree, it would be important to determine which particular features of the form of a word contribute most to the word-type effect, whether the position of these features within a word has an effect, and at what degree of dissimilarity this effect is lost.

Summarising, the findings from the present study suggest that form similarity plays a role in the developing language representations of bilingual children from early on, such that word-type effects found in adult bilinguals are also present in bilingual children. This is in line with the view that the organisation of the developing lexical and conceptual representations of young bilingual children is not essentially different from that of adult second language learners.

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Appendix. *Items used in the present study, together with ratings for phonological similarity, frequency and age of acquisition*

English Picture Naming

Word	Adult Fam	Ch Fam	Form Sim	Frequency		Acquisition	RTCH1	RTCH2	RTAD
				GER	ENG				
Carrot	4.23	3.07	similar	13	3	–	889	1331	1349
Cheese	4.42	–	dissimilar	242	15	1.86	1095	1080	703
Cherry	2.43	2.63	dissimilar	10	8	2.76	1331	680	1037
Cloud	4.05	2.91	dissimilar	74	25	–	1890	2302	1413
Cup	4.59	2.67	dissimilar	74	49	–	1940	1653	1687
Dog	4.05	3.47	dissimilar	1010	47	1.37	605	823	720
Eye	4.50	3.13	dissimilar	1561	104	1.39	1385	1310	950
Helicopter	2.00	3.55	dissimilar	409	16	–	1810	1800	1327
Horse	2.82	3.53	dissimilar	257	60	1.89	1040	743	807
House	3.77	3.13	identical	9998	415	1.65	1028	1190	827
Lion	1.91	2.00	dissimilar	172	13	2.28	1155	1070	927
Pencil	4.00	3.27	dissimilar	153	17	–	1150	1833	1330
Snail	2.45	2.28	dissimilar	26	1	–	1537	2230	1583
Snake	2.05	2.33	dissimilar	360	18	–	1120	1579	1550
Snowman	2.18	3.20	similar	20	0	–	843	1125	1140
Sun	4.45	3.27	similar	1490	75	1.67	1045	985	907
Tree	4.50	3.40	dissimilar	688	69	1.91	1150	1980	993
Trumpet	2.05	2.17	similar	127	6	3.28	1435	893	956
Umbrella	3.41	3.20	dissimilar	62	8	2.74	1845	1159	1193
Window	4.64	2.67	dissimilar	9997	151	2.04	1260	1320	1193
MEAN	3.43	2.94		1337	55	2.07	1278	1357	1132

German Picture Naming

Word	Adult Fam	Ch Fam	Phon Sim	Frequency		Acquisition	RTCH1	RTCH2	RTAD
				GER	ENG				
Bicycle	4.09	3.20	dissimilar	862	10	–	1210	960	977
Butterfly	2.73	3.27	dissimilar	49	1	2.27	1060	1275	853
Cake	3.32	3.93	dissimilar	558	39	–	1000	1060	957
Candle	3.32	3.27	dissimilar	65	4	2.70	1000	1125	663
Cap	2.91	2.72	similar	34	24	–	1250	1500	1243
Cat	4.00	3.00	similar	330	15	1.41	820	1035	873
Church	3.09	2.38	dissimilar	3633	179	2.57	1105	1703	907
Cow	3.18	2.70	similar	166	21	1.70	1525	815	917
Doll	2.50	2.60	dissimilar	126	16	–	1250	1160	967
Drum	2.41	2.10	similar	89	5	2.17	990	1040	1447
Flowers	3.27	3.20	dissimilar	863	27	2.04	1580	1537	2017
Foot	4.59	3.33	similar	7	114	1.54	985	1230	753
Frog	2.38	2.40	similar	86	5	2.26	960	1315	897
Glasses	3.82	2.67	dissimilar	319	45	–	835	1680	773
Letter	3.80	–	dissimilar	1404	136	2.61	1211	1100	847
Rabbit	2.81	3.40	dissimilar	140	6	2.61	980	1225	900
Scissors	3.91	3.33	dissimilar	114	6	2.43	2055	1220	1170
Spider	3.09	1.64	dissimilar	29	2	–	1525	1165	1077
Strawberry	2.77	3.00	dissimilar	5	2	2.35	1220	950	893
Train	3.64	3.07	dissimilar	1507	90	–	1469	1285	1380
MEAN	3.28	2.91		519	37.4	2.20	1200	1217	1026

English Translation

Word	Adult Fam	Ch Fam	Phon Sim	Frequency GER	Frequency ENG	Acquisition	RTCH1	RTCH2	RTAD
Apple	4.48	3.20	similar	212	7	1.91	610	815	333
Bag	–	–	dissimilar	828	23	–	2800	1710	1233
Book	4.68	3.73	similar	2826	307	1.76	1125	1125	357
Bottle	4.41	2.53	dissimilar	405	52	–	1434	2393	517
Bread	4.68	3.13	similar	588	41	–	1206	1411	417
Chair	4.77	2.87	dissimilar	375	87	1.78	1216	869	543
Coat	3.88	2.20	dissimilar	252	53	–	1754	2790	860
Door	4.73	2.60	similar	2002	337	1.57	2017	1380	480
Fridge	4.48	–	dissimilar	182	9	–	3180	4480	415
Goat	2.00	2.07	dissimilar	53	5	–	2856	1627	1144
Kitchen	4.55	–	dissimilar	1092	80	2.09	1870	2423	610
Monkey	2.09	3.20	dissimilar	34	2	–	1940	2033	673
Picture	3.59	–	dissimilar	10050	154	1.76	2070	1887	467
Scarf	–	–	dissimilar	68	6	–	1787	1427	1262
Soap	–	–	dissimilar	73	4	–	1465	1040	364
Spoon	4.64	2.60	dissimilar	58	7	1.50	1993	3220	567
Swing	2.27	2.93	dissimilar	31	13	–	1295	1347	1270
Tooth	–	–	dissimilar	220	10	–	1305	1712	943
Tummy	–	–	dissimilar	386	3	–	1170	1360	843
Water	–	–	similar	3693	387	–	825	1005	343
MEAN	3.95	2.82		1171	79.4	1.77	1642	1624	663

German Translation

Word	Adult Fam	Ch Fam	Phon Sim	Frequency GER	Frequency ENG	Acquisition	RTCH1	RTCH2	RTAD
Bathroom	–	–	dissimilar	118	21	–	2000	1206	738
Biscuit	–	–	dissimilar	16	7	–	1450	1267	777
Duck	2.59	2.67	dissimilar	118	8	1.76	1350	1400	663
Gloves	2.91	2.87	dissimilar	68	17	–	1715	1740	745
Head	–	–	dissimilar	2865	404	–	1555	1385	547
Knife	4.82	2.72	dissimilar	737	38	–	1180	1320	629
Leg	4.73	2.53	dissimilar	331	49	1.52	1275	1255	463
Milk	–	–	similar	475	102	–	758	835	331
Moon	3.32	3.27	similar	376	28	2.00	1290	1080	578
Nose	4.63	2.93	similar	811	41	1.39	1705	830	287
Nut	2.23	3.47	dissimilar	5	4	–	1945	1255	1375
Plate	–	–	dissimilar	184	37	–	1450	1700	956
Potato	3.91	2.93	dissimilar	95	28	–	2285	2434	440
Sheep	2.86	2.44	dissimilar	71	27	1.76	2046	1846	970
Slide	2.70	–	dissimilar	23	7	2.00	1280	2793	1235
Table	4.50	2.53	dissimilar	2332	279	1.78	1660	1245	347
Telly	4.59	4.00	dissimilar	278	66	–	989	1429	862
Toothbrush	4.50	2.87	dissimilar	25	0	–	3229	3608	535
Trousers	4.50	–	dissimilar	281	25	–	2025	775	407
Wall	–	–	dissimilar	826	124	–	930	1445	560
MEAN	3.77	2.94		501.8	65.6	1.74	1597	1480	661