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Research Article

The Role of Multilingualism on Multilingual Memory Representation During Naming and Translation Production Tasks

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Abstract

Purpose: To examine the multilingual memory representation with a number of assumptions including: 1) translation from L2 to L1 and L3 to L1 is faster than the translation from L1 to L2 and L2 to L3 due to conceptual mediation effect in the latter, 2) naming in L1 is faster than that in L2 and L3 due to phonological and lexical access latencies in the latter, 3) recall after translation is better than that after naming and L1 recall rate would be better than that of L2 and L3 and 4) L3 performance be it in recall, naming or translation productions tasks would be better due to recency effect.

Method: The study was carried out using the SuperLab version 5, conducted on the Language Lab where 20 multilinguals took part in the study. The examined languages were Arabic (as either L1 or L3), English (as L3 almost) and Turkish (as either L1 or L3). A list of 144 words in the form of 12 categories and then two lists: categorised and randomised was used. Three tasks were undertaken: naming, translation production and incidental recall tasks.

Results: Our findings which were based on the collected Response times (RTs), retrieval rates and statistical analyses using the Minitab 17- indicated that translation from L2 to L1 and L3 to L1 was only faster than that of L1 to L2 and L1 to L3 when using randomised lists. Besides, translation from L2 to L3 and L3 to L2 were not consistent where the former was shorter in the categorised lists but longer in the randomised lists. As for naming, it was shorter for L1 in both the categorised and randomised lists. However, while the lexicon size of L1 approved to be the largest with the fastest RTs, the RTs for L2 and L3 were variable affected by the type of used lists: categorised or randomised. Also, retrieval rate was higher after naming in the categorised lists but not in the randomised lists where the retrieval rate after translation was higher. The difference of retrieval rate was not significant between naming and translation tasks though it was higher in favour of the naming task. The recency effect was not absolute where it was only showed when using the randomised list that the RTs of L3 in both naming and translation tasks had faster RTs than those of L2.

Conclusion: 1) Conceptual access is not required while naming-resulting into faster naming times as compared to picture naming or translation which require conceptual access 2) the representation of multilingual memory seems to be developmental other than that assuming lexical or conceptual, 3) neither the word association nor the concept mediation hypotheses are consistent with our output; the developmental hypothesis assuming variability and influence of dominance language is more consistent with our output., and 4) categorisation could play the role of either facilitation or interference as it supported the incidental recall to overcome that of translation in our study and it also lead to less retrieval rate after translation.

Keywords: *Multilingual Memory Representation; Conceptual Mediation; Lexical Mediation; Developmental Mediation; Naming Task; Translation Production Task; Incidental Recall Task*

Introduction

Multilingual memory representation has been an area of interest in the last few decades. In other words, the investigation of the way how multilinguals organise, store and associate linguistic knowledge in their minds seems to be full of ambiguities, albeit several research has been conducted on bilingual memory representation.

Actually, Research on multilingual memory is generally based on findings from bilingual memory. By this means, multilingual memory representation is examined using bilingual memory representation models. Early investigations of bilingual memory representation are attributed to Weinreich [1] who introduced subordinate relationship (one languages is dominant i.e. L1) and coordinate (two items are linked to a similar concept) between first language L1 and second language L2. This could be illustrated in the following diagram.

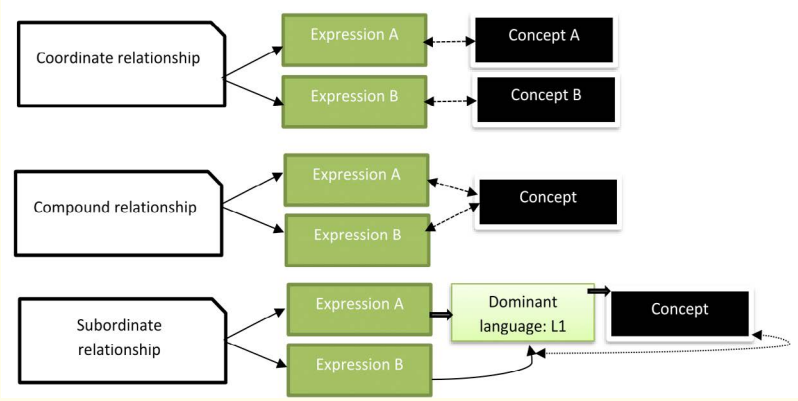

Figure 1: *Weinreich's (1953) model of bilingual memory representation.*

Based on this model, three influential models were established: word association hypothesis i.e. words from L1 and L2 are directly associated with one another, concept mediation hypothesis i.e. words of L1 and L2 are associated through a conceptual store and developmental/intermediate hypothesis i.e. in early levels L1 and L2 words are associated to one another directly, but in advanced stages they move to conceptual mediation [2-5].

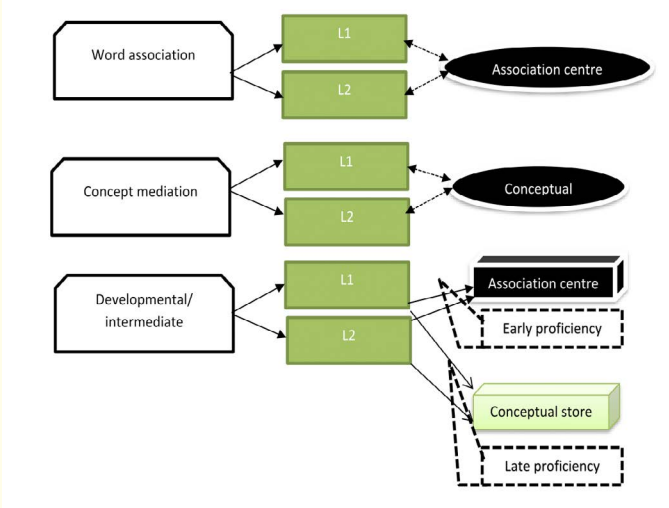

Figure 2: *Early bilingual memory representation hypotheses.*

In detail, it has been already mentioned above that multilingual memory representation is mainly based on literature from bilingual memory representation. In other words, while the latter is still an argumentative issue among researchers, the former stands as another puzzle that will either support previous literature or replicate it and propose a new model applicable only to multilingual memory representation. Early studies on bilingual memory representation measuring reaction times (hereafter RTs) using picture naming and translation tasks-supported conceptual mediation model [5]. Other studies investigated bilingual memory representation affected by proficiency level ending up with a view supporting the developmental hypothesis [6,7].

Having this in mind, other researchers attempted a revised model for these models. Consider for instance, Kroll and Stewart [4] who through three experiments using picture naming and translation tasks reached the view that while translation from L1 to L2 is conceptually mediated, translation from L2 into L1 is lexically mediated. The authors assume the availability of cross language connections between lexical representations and conceptual ones which are asymmetric. This model has not been applied on multilingual memory representation according Angelis [8] seems to be worth attempting as shown on our raised questions below.

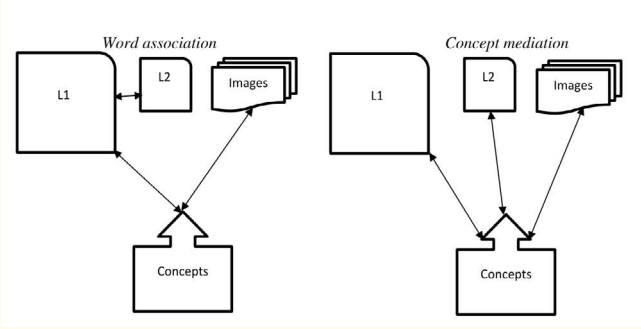

Figure 3: *Early models of bilingual memory interconnection in Kroll and Stewart (1994).*

As we have already mentioned, supporting their view with recent studies, a revised model was proposed as illustrated in the following diagram.

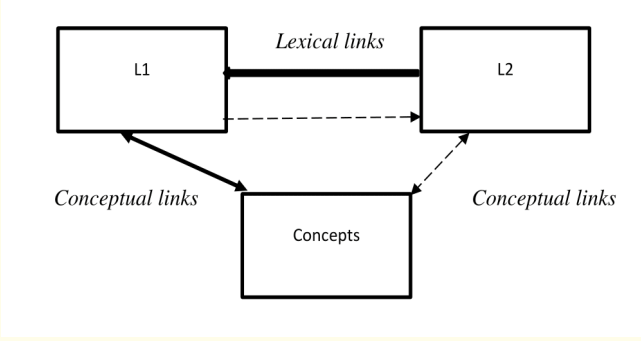

Figure 4: *Revised model of bilingual memory representation in Kroll and Stewart (1994).*

Another common approach in the study of bilingual memory representation, yet has been applied on multilingual memory representation [9,10]. This proposal is based on the study of abstract and concrete words assuming basically the availability of a shared node for concrete words in bilinguals, but specific conceptual representations for the abstract words.

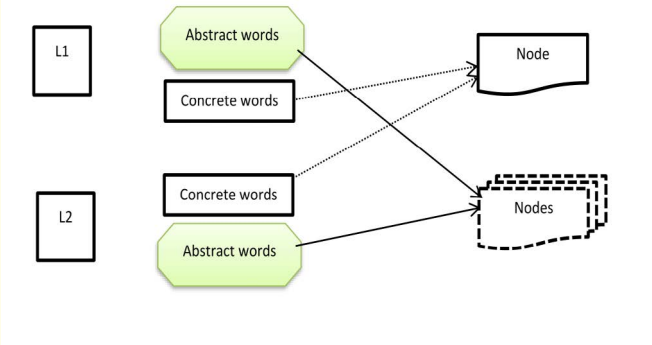

Figure 5: *Developmental model of bilingual memory representation according to Groot (1993).*

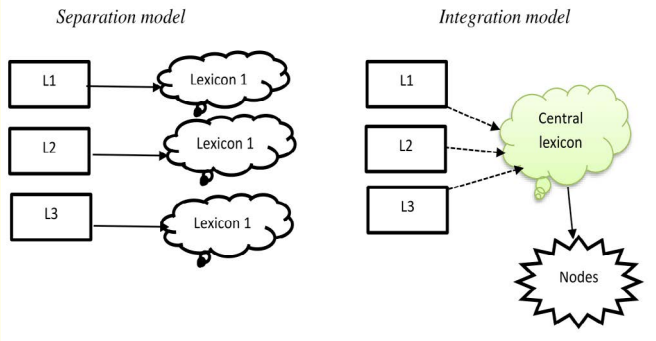

Figure 6: *Extended developmental model of multilingual memory representation according to Groot and Hoecks (1995).*

Similar studies following this approach examined the relationship between first language and second and third languages e.g. Abunuwara [11] who examined the relationship of Arabic to Hebrew and English as L2 and L3. Studies like this assumed that the relationship between L2 and L3 is independent, L1 and the weak non-native language has inter-dependent relationship and L1 and the strong non-native language have intermediate relationship.

Moreover, other researchers attempted examining the effect of processing load on the performance of multilinguals in terms of accuracy of production and speed which was verified by Festman's study [12]. More specifically, they examined memory storage capacity and processing load assuming interference of lexical capacity on production e.g. Magiste [13], Tulving and Colotla [14], Schönpflug [15], Magiste [16] and Magiste [17] who examined the difference between active and passive bilingualism with the former as a facility for acquisition of L3 and the latter as an obstacle for the acquisition of L3.

A more debated area of multilingualism is that arguing in favour or against separation and integration of two or more lexicons in the mind. While the proponents of the integration approach assume having the same lexicon which is then supported by different nodes for each new acquired language; their opponents i.e. following the separation approach assume the availability of different lexicons in the mind, one for each language [8,18]. In spite of this, modified versions of these models have raised e.g. Paradis [19] and Caramazza and Coltheart [20], who assumed partial separation in terms of functions, but full integration in terms of anatomy. Evidences for the first approach have generally come from studies on neurolinguistics, recent language affect, and cross-linguistic studies e.g. Albert and Obler [21], Paradis [19], Singleton [18,22], Ecke [23] and Herwig's [24] prospectively.

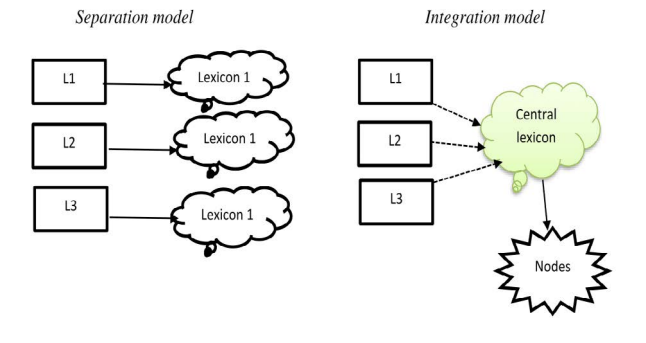

Figure 7: *Separation and integration models of multilingual memory storage.*

On the other hand, other studies have been supporting the integration approach. For instance, Cook [25] introduced monocompetence and multicompetence terms to distinguish between L1 and other acquired languages. Kroll and Dijkstra [26] have also supported the same approach, but in terms of word recognition studies. Dijkstra [27] accounted for these two approaches in terms of selective [separation] and non-selective [integration] lexical access. In their study, Van Hell and Dijkstra [28] examined this view in relation to cognate and non-cognate words on multilinguals (Dutch L1, English L2 and French L3). Although this view is approved, but it was contradictive as an effect was approved only on L1 and L2 but not on L1 and L3. After considering the view of Grosjean [29], in regard to the effect of recent use of the language (Language Mode Hypothesis) i.e. Dutch and English in the Netherlands, but not Dutch and French, the authors replicated their study with more proficient speakers of L3.

Additionally, a major model supporting the integration view is that based on Interactive Activation model (IA). Basically, the IA model was proposed by McClelland and Rumelhart [30] in the study of monolingual word recognition. Later on, it was extended to bilinguals as Bilingual Interactive Activation (BIA) model [31]. And recently was extended for multilinguals as the Multilingual Interactive Activation (MAI) model by Dijkstra [27]. While the AI model assumes three levels for word recognition as feature, letter and word; the BAI model assumes four levels: feature, letter, word and language i.e. node levels. The lexicon is integrated at the word level, but not anymore at the language or node level [32]. In the case of MAI model, the only difference is that in the case of node level, it 'contains the language tags of all the corresponding languages' [8].

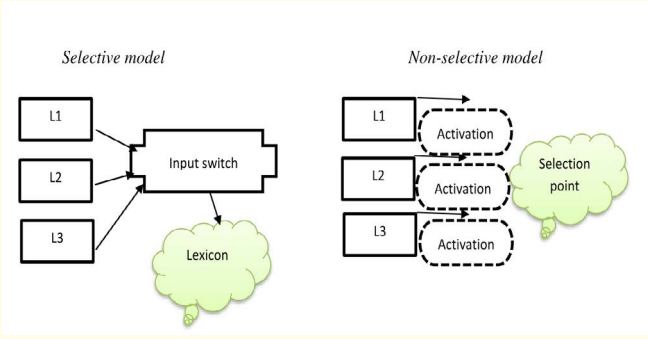

Figure 8: *Selective and non-selective lexical access supporting integration model.*

The Interactive Activation model IA according to McClelland and Rumelhart [30], Bilingual Interactive Activation (BIA) model according to Dijkstra and Van Heuven [31], and Multilingual Interactive Activation (MAI) model according to Dijkstra [27].

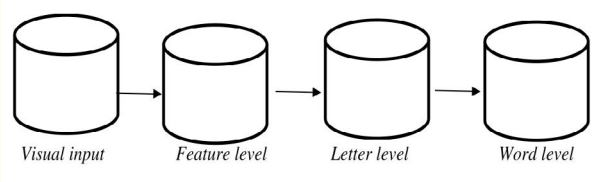

Figure 9: *Monolingual visual word recognition model.*

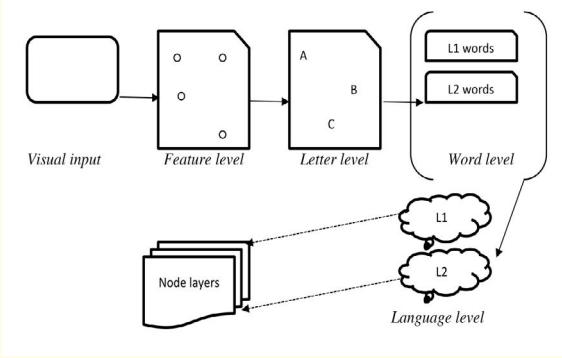

Figure 10: *Bilingual Interactive Activation (BIA) model.*

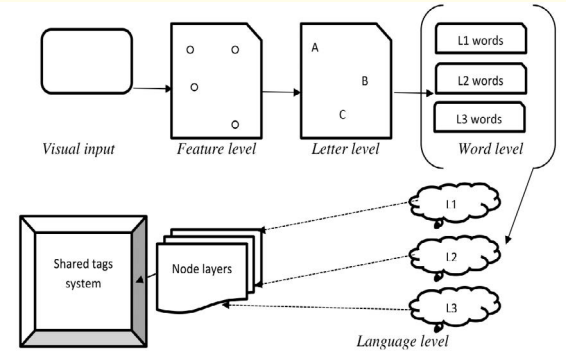

Figure 11: *Multilingual Interactive Activation (MAI) model.*

Thus, yet more specifically based on Kroll and Stewart [4], following Angelis [8] and investigating also the other proposed multilingual memory representation models above, this study attempts answering the following questions:

1. If translating from the L1 into the L2 is conceptually mediated, would translating from the L1 into the L3 would be conceptually mediated too?
2. If translating from the L2 into the L1 is lexically mediated, would translating from the L2 into the L3 be lexically mediated as well?
3. If translating from the L2 into the L1 is lexically mediated, would translating from the L3 into the L1 and the L3 into L2 the same as well?

Method

Sample

The population of this study included students who meet the following characteristics:

1. They speak either Arabic or Turkish as mother tongue language;
2. They speak in addition to their mother tongue language two additional languages as L2 and L3;
3. They are university students and residing in Ankara, Turkey; and
4. They don't have any abnormal psychiatry records.

The study was conducted in the Department of Linguistics (Language Lab), Ankara University, Ankara, Turkey between the period of 01/03/2016 and 15/05/2016.

The participants were generally students from those residing in Turkey for educational purposes in the case of those who speak Arabic as L1 and English and Turkish as L2 and L3. On the other hand, the other participants were Turkish students who know Arabic as L2 and English as L3. Our sampling included 20 students.

Setting: This study was conducted in the Lab of Language, Department of Linguistics, Faculty of Languages, History and Geography, Social Sciences Institute, Ankara University, Ankara, Turkey.

Measures

The study was based on a list of 144 lexical items in Arabic, English and Turkish where this list was used in the form to two groups. First, the list was used in terms of 12 categories 12 x 12 = 144. The same list was then randomly classified to have a randomised list 12 x 12 = 144. Details of this list is given below.

Variable	Total count	Missing	Mean	Minimum	Maximum
Arabic word frequency	144	0	1686	45	6973
English word frequency	144	0	674	3	19410
Turkish word frequency	144	0	5511	147	75988

Table 1: *Frequency means and range.*

Language	Total count	Missing	Mean	Minimum	Maximum
Arabic	144	0	4.021	2	13
English	144	0	5.757	3	11
Turkish	144	0	5.618	2	14

Table 2: *Number of characters in means and range.*

Language	Name	Total
Arabic	A frequency dictionary of Arabic by Buckwalter, T., & Parkinson, D. (2014)	30 million word
English	Word Frequencies in Written and Spoken English: based on the British National Corpus by Leech, G., Rayson, P., & Wilson, A. (2001)	100 million words
	The Corpus of Contemporary American English (COCA) by Davies, M. (2015), Brigham Young University	520 million words
Turkish	Turkish National Corpus (TNC) Demo Version by Aksan, Y., Aksan, M., Mersinli, Ü., Demirhan, U. U., & Yilmazer, H. (2012)	48 million word

Table 3: *Source of lexical items.*

144 words: category							
Animals	12	Body	12	Food	12	Clothing	12
Transport	12	Family	12	Time	12	Professions	12
Emotions	12	Health	12	Technology	12	Nationalities	12

Table 4: *Categories of lexical items in the categorised group.*

Design

The study was designed following the experimental approach to examine the relationship among L1, L2 and L3 lexicon(s) in the mind or in terms of multilingual memory representation. The design of the study and the tested hypotheses could be depicted below as the following:

L1 ↔ L2 Y	where:
L2 ↔ L1 X	L1= First Language
L1 ↔ L3 O	L2= Second Language
L3 ↔ L1 X	L3= Third Language
L2 ↔ L3 O	↔= Relationship
L3 ↔ L2 O	Y, X, O= types of relationships i.e. conceptual, lexical and developmental

Table 5: *Design.*

Procedure

The experiment was designed in the Language Lab using the SuperLab (version 5). Each participant started with filling in the Language History Questionnaire. This step was followed by a short introduction explained by the researcher to each participant using illustrating cards. Each participant started with the naming session: L1, L2 and then L3. After naming each list, the participant wrote down the words s/he could recall. The second session was the translation session where it included six conditions as shown in table 9. In the first three conditions, the participants were also asked to document the words s/he could retrieve after each condition. The whole process lasted for about 25 minutes including filling in the questionnaire and the introductory sessions. All these sessions and steps are summarised in the following tables 6-9.

Task	Method	Documentation tool
Naming	Oral production	SuperLab
Translating	Oral production	SuperLab (5)
Incidental recall	written	Writing down

Table 6: *Performed tasks by each participant.*

Reaction time (RT)	Faster+ =	Conceptual
	Slower+ =	Lexical
	Faster- = Slower- =	Developmental Developmental
	Equal =	Developmental

Table 7: *Measured factor.*

Categorised condition			Randomised condition		
Arabic	**English**	**Turkish**	**Arabic**	**English**	**Turkish**
كلب	dog	köpek	كلب	dog	köpek
طق	cat	kedi	بلق	heart	kalp
سمك	fish	balık	ءام	water	su
بقرة	cow	inek*	حذاء	shoes	ayakkabı
رمن	tiger	kaplan*	قيرط	road	yol
دسأ	lion	aslan	خأ	brother	erkek kardeş
حمار	donkey*	eşek	مرة	once	bir defa
حصان	horse	at	ئيس	president	başkan
جمل	camel*	deve	عربي	Arabian	Arap
فيل	elephant	fil*	سعيد	happy	Mutlu
رأف	mouse	fare	طبيب	doctor	doktor
ئبذ	wolf	kurt	جمانرب	programme	program

Table 8: *A sample of used lists.*

L1	L2	Categorised	L1	L2	Randomised
	L3			L3	
L2	L1		L2	L1	
	L3			L3	
L3	L1		L3	L1	
	L2			L2	

Table 9: *Performed trails by each participant in categorised and randomised lists.*

Data-collection: Using the SuperLab programme (version 5) and its experimental devices i.e. voice recorder, voice tracker, microphone and the experimental room in the Language Lab in the Department of Linguistics, Ankara University, Ankara, Turkey- response/reaction times (RTs) for the 3 naming conditions (L1, L2 and L3) and the six translation production conditions were accordingly recoded.

Preliminary analysis steps: In order to answer the raised questions in this study, the collected RTs were analysed using the Minitab statistical programme (17th version). Mostly, both descriptive and inferential statistical tools were used to answer the questions of the study and test its hypotheses. Besides, the collected data using the Language History Questionnaire was reported as an introductory section in the results. The analysis was introduced starting with: Language History Questionnaire report, incidental recall report, naming report and finally translation production report.

Results

We have mentioned above that in the literature of bilingualism and multilingualism the issues of both bilingual memory representation and multilingual memory representation are still argumentative. We specifically referred to the early and revised models of Kroll and Stewart [4] in regard to conceptual and lexical representation of bilingual memory (Figure 4) with the aim of the application of this model on multilingual memory representation. We also referred to the MIA model (Figure 11) which has had already scarce data on multilingual memory representation. The results of this study are a worth addition where by Kroll and Stewart's [4] model was tested for the first time on multilinguals and the MIA model Dijkstra [27] was further verified. The analysis includes: language history questionnaire report, incidental recall task report, and naming and translation production tasks report. The used statistical tools are summarised in this table.

Statistics	Minitab-17 tool	Type	Purpose
Descriptive statistics	Mean, SD, Max and Min	Table	Incidental recall task values
		Table Table	Naming task values Translation production task values
	Means: graphs	Graph Graph	Means of naming task latencies in milliseconds Means of translation production task latencies in milliseconds
Inferential statistics	Test for Equal Variances	Tables and Charts	Testing significance difference of incidental recall during naming and translation production tasks
	One-way ANOVA	Tables and Charts	Testing significance in general among naming task (groups) and translation production task (groups)
	Two-sample T-Test	Tables and Charts	Determining whether the mean differs significantly between each two groups i.e. (L1 and L2 etc.) in both naming and translation production tasks

Table 10: *Used statistical tools for data analysis using Minitab-17.*

Language history questionnaire report

There were 20 participants in this study. The participants were generally Arab and Turkish students who were studying in different universities in Ankara, Turkey. The Arab students were mostly from Yemen and Sudan with one of them from Chad who speaks Arabic as a mother tongue language. In the case of Turkish participants, two of them have double nationalities: one as Iranian and Turkish and another as American and Turkish. The age range of the participants was (18 - 32) (M = 22.75). As for gender, the participants included 7 females and 13 males. The country of birth for each participant was identical to the mother tongue language s/he speaks except for three of them: one was born in the United Arab Emirates (UAE), one was born in the United States of America (USA) and the third was born in Turkmenistan. In the case of the first participant, there is no effect as the languages are the same (Arabic) in both Sudan and UAE. None of the participants has also his mother or father with a different nationality or mother tongue language except for one whose parents are Iranians and she was born in Turkey with both Turkish and Iranian nationalities.

The academic qualifications varied. 17 of them are doing their bachelor degrees, one is still doing a preparatory language year before starting his bachelor degree, one is doing her MA degree and two are doing their PhDs. Their fields of study included: engineering (2), chemical engineering (3), archaeology (1), TV and media studies (1), chemistry (2), Arabic Studies (6), Linguistics (2), economy (1), political science (1) and international relations (1).

In regard to language history and/or multilingualism record, twelve of the participants have Arabic as L1, English as L2 and Turkish as L3. One of the participants has both Arabic and French as his mother tongue languages (Chad). One of the participants has also Russian and Turkmen as her mother tongue languages (Turkmenistan). Another also has both Persian and Turkish as her mother tongue languages (Turkish with Iranian parents). The rest five participants have Turkish as L1, Arabic as L2 and English as L3. They are doing their bachelor degrees in Arabic linguistics and literature and they were mostly in their fourth year.

Some of the participants indicated also their knowledge of more than the three investigated languages: Arabic, English and Turkish. One of them indicated his knowledge of Hebrew, Persian, French and German in addition to L1 (Turkish), English (L2) and Arabic (L3). Another also indicated her knowledge of Dutch as L4 in addition to Turkish as L1 and English as L2 and Arabic as L3. One more participant stated her knowledge of Turkish and Persian as L1 and English as L2 followed by Arabic as L3. Three more participants mentioned their knowledge of French as L4 in addition to Arabic as L1, English as L2 and Turkish as L3. One participant also indicated his knowledge of both Arabic and French as L2 in addition to Turkish as L2 and English as L3. A participant also stated that both Russian and Turkmen as her L1 in addition to English as L2, German as L3 and Turkish as L4. Finally, two participants indicated their knowledge of Russian as L4 in addition to Arabic as L2, English as L2 and Turkish as L3.

We also attempted to gather some data about the age of acquisition and/or learning for each language. None of the participants has manifested any psychiatric disorder. The first language was smoothly acquired for all the participants. However, four of the participants have manifested the double mother tongue situation. One of the participants was born in Turkey for an Iranian parents. According to her, they used to communicate with me in both with more focus on Persian so that I cannot miss their native tongue language. They also used to spend their holidays in Iran. Being a bachelor student now in the Department of Arabic Language, she stated that both Persian and Turkish as both her mother tongue languages. Another participant from Chad stated that there is no choice for Muslims in Chad, but to acquire both Arabic and French in order to balance between the social and professional lives. One more participant stated that she was born in the USA and stayed there until the age of six. According to her, Turkish and English are both her mother tongue languages. Another participant also from Turkmenistan stated that both Turkmen and Russian stand together for most of the people in her country. Finally, one more participant also indicated that he was born and grown up in the UAE where they speak Gulf Arabic, different from the Arabic of Sudan, albeit the communication between the dialects is highly successful. By all means, he can use both dialects that of Sudan and the UAE with more preference to the former.

Having accounted for L1 age of acquisition, we now shed light on the additional languages acquisition of our participants. The age range of L2 acquisition is between 5-21 years with the (M = 11.052). There is only one of the participants who has started the acquisition/learning of L2 after the age of 12 (age 21). All other participants have started acquiring/learning L2 at 5, 6 or at the age of 12. The range of L3 acquisition/learning is between 15-30 years with the (M = 19.55).

We also gathered information about the nature of acquisition of each language. Three characteristics were used: formal, informal, both where 'formal' indicates that the language was acquired and learned in a/the country where the language is spoken as mother tongue language e.g. Arabic in Yemen, Turkish in Turkey, etc. 'Informal' indicates that the languages was acquired/learnt in a foreign country e.g. learning/acquiring English in Saudi Arabia. 'Both' indicates that both situations were possible e.g. learning/acquiring English in Saudi Arabia and the UK. To start with L1, with the exception of four participants, all other participants have acquired/learnt L1 in the formal status. We have already stated that four of the participants have double mother tongues (English-Turkish), (Persian- Turkish), (Arabic-French) and (Russian- Turkmen). In the case of L2 (English), it was mostly informal except for two participants (both) where one was born in the USA and stayed there until the age of 6 and one has stayed there for about one year. Similarly for the case of L3 (Turkish) it is both as the students are residing in Turkey. On the other hand for those whose L3 is Arabic, it is informal as they are doing their bachelor degrees in Arabic studies in Turkey without any travel record to Arabian countries or where Arabic is being used as L1.

Moreover, we also tried to collect data about the level of each language using the European Union portfolio level indicators (A1=basic-C2=high proficiency). The determination of the level was based on the provided answers of the participants and the certificates they carry for each language. For the case of Arab participants, they generally have C1 levels in both L2 (English) and L3 Turkish with three of them of B2 level in Turkish and B1 in English. In the case of those who indicated the knowledge of L4, they indicated that they have gained A1 certificates. In the case of Turkish participants, their knowledge of Arabic is formally higher than C1 level as they are doing their bachelor degrees in Arabic studies. All of them were in the fourth year.

The last part of the language history questionnaire was in relation to travel history record. The purpose was to consider any external influences in the learning and acquisition of the included languages in our study. All the participating Arabs have been available in Turkey for educational purposes. Only one of them indicated that she stayed in the USA for one year and a short visit for the Netherlands (conference) while doing her bachelor degree in political science. One of the Turkish participants indicated her leave to Jordon and Israel; however, the periods were very short (not exceeding 2 months in each). We have also mentioned that one of the Turkish participants was born in the USA and stayed there until the age of six in addition to two years in Bosnia and about 2 months in Jordon.

Incidental recall statistical report

Task	List	Language	Count	Sum	Maximum	Minimum	Mean	SD
Naming	Categorised	L1	14	106	10	4	7.571	2.277
Naming	Categorised	L2	14	96	10	3	6.857	2.033
Naming	Categorised	L3	14	84	10	2	6.000	2.219
Translation	Categorised	L1-L2	14	96	11	4	6.857	1.834
Translation	Categorised	L1-L3	14	97	11	4	6.929	1.900
Translation	Categorised	L2-L1	14	94	10	4	6.714	2.054
Translation	Categorised	L2-L3	14	94	10	4	6.714	2.054
Translation	Categorised	L3-L1	14	89	9	2	6.357	2.274
Translation	Categorised	L3-L2	14	89	9	2	6.357	2.274
Naming	Randomised	L1	6	39	9	5	6.500	1.517
Naming	Randomised	L2	6	38	8	4	6.333	1.366
Naming	Randomised	L3	6	38	9	4	6.333	2.338
Translation	Randomised	L1-L2	6	40	10	4	6.667	2.160
Translation	Randomised	L1-L3	6	43	10	4	7.167	2.317
Translation	Randomised	L2-L1	6	44	10	4	7.333	2.160
Translation	Randomised	L2-L3	6	44	10	4	7.333	2.160
Translation	Randomised	L3-L1	6	43	10	4	7.17	2.79
Translation	Randomised	L3-L1	6	40	10	4	6.67	2.66

Table 11: *Incidental recall report in means, standard deviations and range.*

A descriptive statistics tool was administered to present an initial report for the incidental recall task. The purpose was to see if there were difference in the total retrieved words among the different conditions after both naming and translation production tasks. In the case of naming task, the total retrieved words after L1 naming seems to be significant compared to those in L2 and L3 (M = 7.57, SD= 2.27). The lowest total retrieved words was in the case of L3 (M = 6.00, SD = 2.22). Similar to this is in the case of the total retrieved words after naming task with randomised list of words, L1 values were slightly higher (M = 6.50, SD = 1.51). Moreover, the total of retrieved words after translation production tasks was also higher in the case of L1 (L1-l2 and L1-L3) with a slight difference in favour of the latter (Ms = 6.85 and 6.93, SDs = 1.83 and 1.90). In comparison, the total of retrieved words after translation production task in the case of randomised lists of words seems to be different in favour of the L2 (L2-L1 and L2-L3) (Ms = 7.33 and 7.33, SDs = 2.16 and 2.16). In conclusion, one could say that incidental recall after naming in both categorised and randomised lists of words is better in the case of L1, this applies to the case of translation production task in the case of categorised list, but not in the case of randomised list where L2 participants retrieved slightly higher than those in L1 and L3 conditions.

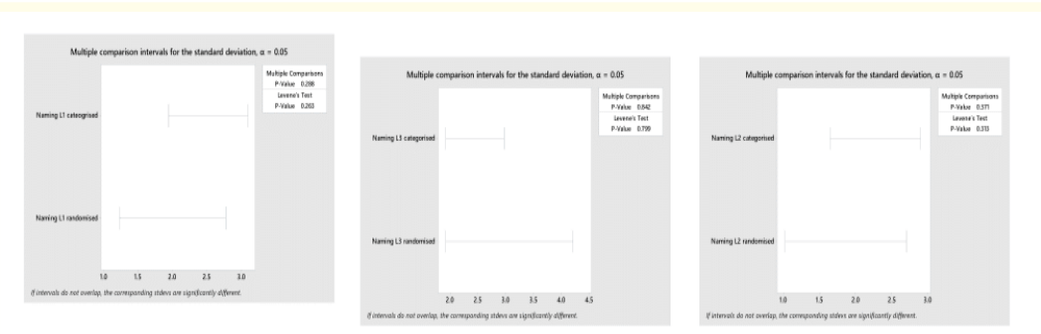

Figure 12: *Incidental recall significance after naming in L1, L2 and L3.*

A Test for Equal Variances was conducted to determine if incidental recall-retrieved words were different for multilinguals with categorised and randomised lists after naming task. The assumptions in this case are: H_0*: recall percentages are equal after naming by L1, L2 and L3 participants in both categorised and randomised lists and H1: recall percentages after naming by L1, L2 and L3 participants in both categorised and randomised lists are not equal*. The results of our study will be positive if the null hypothesis is rejected, that is the p-value is ≤ α. Participants were 20 (males and females) and the data was classified into two main groups: naming L1, L2 and L3 (categorised list), naming L1, L2 and L3 (randomised list). Therefore, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 1.33, p = .263. Thus, because p > 0.05, it could be concluded that recall after naming seems to be equal when using categorised and randomised lists of words in L1. In L2, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F= 1.08, p = .313. Thus, because p > .05, it could be concluded that recall after naming seems to be equal when using categorised and randomised lists of words in L2. As for L3, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F= 0.07, p = .799. Thus, because p > .05, it could be concluded that recall after naming seems to be equal when using categorised and randomised lists of words in L3. Besides, interval plots were also generated to see the distribution of the sample's central tendency and variability between the naming L1, L2 and L3 in categorised and randomised lists. While the SDs seem to be different, the differences are probably not significant because all the interval bars easily overlap.

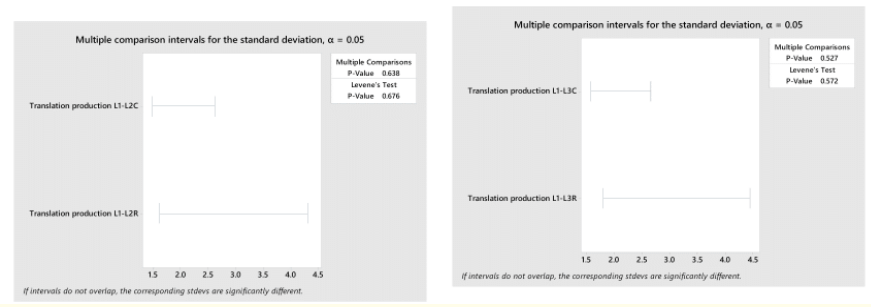

Figure 13: *Incidental recall significance after translation production task in L1-L2 and L1-L3.*

A Test for Equal Variances was conducted to determine if incidental recall-retrieved words were different for multilinguals with categorised and randomised lists after translation production task. The assumptions in this case are: H_0*: recall percentages are equal after the translation production task in L1-L2 and L1-L3 participants in both categorised and randomised lists and H1: recall percentages after the translation production task in L1-L2 and L1-L3 participants in both categorised and randomised lists are not equal*. The results of our study will be positive if the null hypothesis is rejected, that is the p-value is ≤ α. Participants were 20 (males and females) and the data was classified into two main groups: translation L1 to L2 and L1 to L3 (categorised list), translation L1 to L2 and L1 to L3 (randomised list). There wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 1.18, p = .676. Thus, because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L1-L2. In the case of L1-L3, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 0.33, p = .572. Thus, because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L1-L3. Additionally, interval plots were also generated to see the distribution of the sample's central tendency and variability between the two lists. While the SDs seem to be different, the differences are probably not significant because all the interval bars easily overlap.

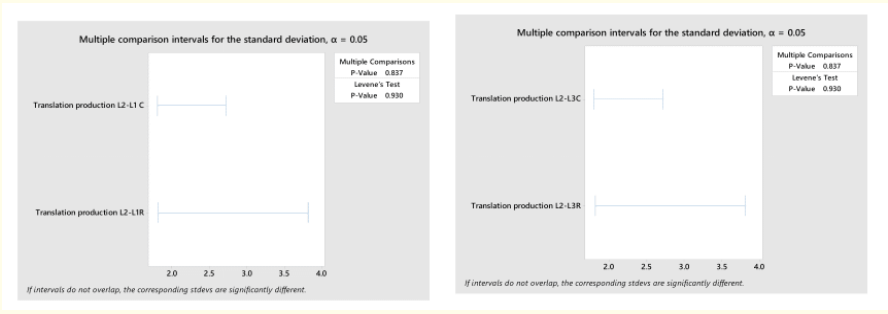

Figure 14: *Incidental recall significance after translation production task in L2-L1 and L2-L3.*

A Test for Equal Variances was conducted to determine if incidental recall−retrieved words were different for multilinguals with categorised and randomised lists after translation production task. The assumptions in this case are: *H_0: recall percentages are equal after the translation production task in L2-L1 and L2-L3 participants in both categorised and randomised lists and H1: recall percentages after the translation production task in L2-L1 and L2-L3 participants in both categorised and randomised lists are not equal*. The results of our study will be positive if the null hypothesis is rejected, that is the p-value is ≤ α. Participants were 20 (males and females) and the data was classified into two main groups: translation L2 to L1 and L2 to L3 (categorised list), translation L2 to L1 and L2 to L3 (randomised list). There wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 0.01, p = .930. Thus, because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L2-L1. In the case of L2-L3, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 0.01, p = .930. Thus, because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L2-L3. In addition, interval plots were also generated to see the distribution of the sample's central tendency and variability between the two lists. While the SDs seem to be different, the differences are probably not significant because all the interval bars easily overlap.

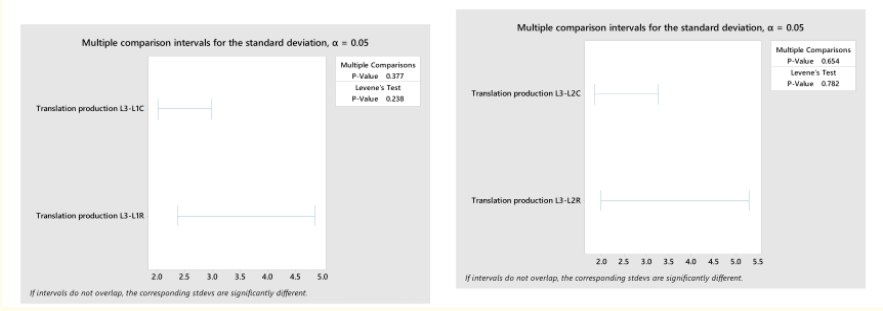

Figure 15: *Incidental recall significance after translation production task in L3-L1 and L3-L2.*

A Test for Equal Variances was conducted to determine if incidental recall-retrieved words were different for multilinguals with categorised and randomised lists after translation production task. The assumptions in this case are: *H_0: recall percentages are equal after the translation production task in L3-L1 and L3-L2 participants in both categorised and randomised lists and H1: recall percentages after the translation production task in L3-L1 and L3-L2 participants in both categorised and randomised lists are not equal*. The results of our study will be positive if the null hypothesis is rejected, that is the p-value is ≤ α. Participants were 20 (males and females) and the data was classified into two main groups: translation L3 to L1 and L3 to L2 (categorised list), translation L3 to L1 and L3 to L2 (randomised list). There

wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 1.49, p = .238. Thus, because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L3-L1. In the condition L3-L2, there wasn't a statistically significant difference between groups as determined by a test for equal variances, F = 0.08, p = .782. For that matter and because p > .05, it could be concluded that recall after the translation production task seems to be equal when using categorised and randomised lists of words in L3-L2. An interval plot was also generated to see the distribution of the sample's central tendency and variability between the two lists. While the SDs seem to be different, the differences are probably not significant because all the interval bars easily overlap.

Naming and translation production tasks report

Variable	Mean	SD	Minimum	Maximum
Naming L1 Categorised	1101.6	163.4	776	1495
Naming L2 Categorised	1112.7	207.8	726	1588
Naming L3 Categorised	1203.4	238.6	613	1698
Naming L1 Randomised	1073.6	163.8	729	1425
Naming L2 Randomised	1179.1	202.2	731	1580
Naming L3 Randomised	1117.7	156.5	731	1549
L1-L2 Categorised	1268.9	192.6	818	1847
L1-L3 Categorised	1310.5	211.5	829	1697
L2-L1 Categorised	1274.4	237.9	783	1744
L2-L3 Categorised	1336.8	212.9	667	1697
L3-L1 Categorised	1344.3	242.6	896	1988
L3-L2 Categorised	1350.0	299.6	671	1987
L1-L2 Randomised	1217.4	204.2	731	1777
L1-L3 Randomised	1201.5	225.0	731	1597
L2-L1 Randomised	1209.2	258.9	731	1849
L2-L3 Randomised	1289.5	271.6	731	1797
L3-L1 Randomised	1205.7	198.1	731	1672
L3-L2 Randomised	1256.9	216.6	731	1834

Table 12: *Means, SDs, the highest and the lowest response times during naming and translation production tasks.*

The above table shows the Ms, SDs, Maximum and Minimum RTs in milliseconds (ms) during both naming and translation production tasks using categorised and randomised lists of words. Generally, the ms of RTs during translation production task are significantly higher than those during naming task be in in the case of categorised and randomised lists. While the maximum RT during naming task is (1698), the maximum RT during translation production task is significantly higher (1988). Regardless of whether RTs are higher or lower in the case of categorised list of words, this tables indicates clearly that RTs are generally yet significantly longer during translation production task than naming task.

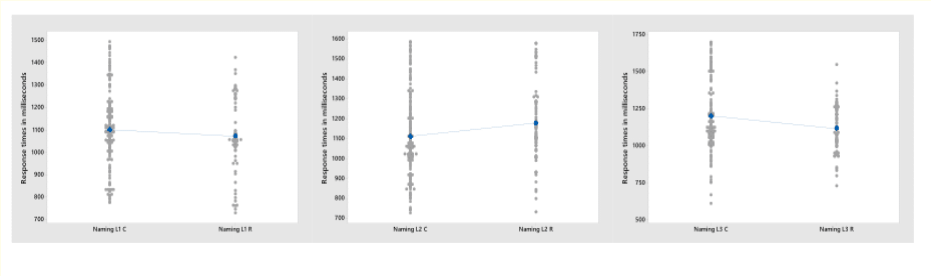

Figure 16: *The association between calculated response times during naming task in L1, L2 and L3.*

An independent t-test was run on a sample of 168 items (in each categorised list column) and 72 items (in each randomised list column) to determine if there were differences in response times RTs between L1, L2 and L3 (categorised lists) and L1, L2 and L3 (randomised lists) during naming task based on categorised and randomised lists of words. Both groups (males and females) consisted of 20 multilinguals. It was hypothesised that H_0: $\mu_1 - \mu_2 = \delta_0$ (indicating that RTs are equal during L1, L2 and L3 naming task) and alternatively H_1: $\mu_1 - \mu_2 \neq \delta_0$ (indicating that RTs are not equal during L1, L2 and L3 naming task). The results showed that RTs during naming in categorised lists of L1 had statistically insignificantly longer RTs (1102 ± 163) compared to that in randomised lists (1074 ± 164), t (134) = 1.21, p = 0.228. In comparison, in the case of L2, the results showed that RTs during naming in randomised lists of L2 had statistically significantly faster RTs (1113 ± 208) compared to that in categorised lists (1179 ± 202), t (137) = 2.31, p = 0.022. In the case of L3, the results showed that RTs during naming in categorised lists of L3 had statistically significantly longer RTs (1203 ± 239) compared to that in randomised lists (1118 ± 156), t (198) = 3.29, p = 0.001.

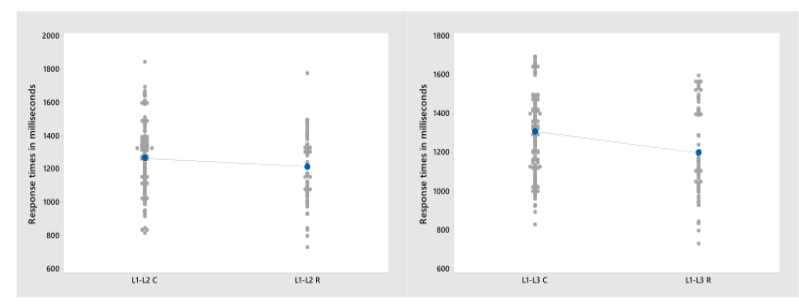

Figure 17: *The association between calculated response times during translation production task in L1-L2 and L1-L3.*

An independent t-test was run on a sample of 168 items (in each categorised list column) and 72 items (in each randomised list column) to determine if there were differences in response times RTs between L1 to L2 and L1 to L3 (categorised list) and L1 to L2 and L1 to L3 (randomised list) during translation production task based on categorised and randomised lists of words. Both groups (males and females) consisted of 20 multilinguals. It was hypothesised that H_0: $\mu_1 - \mu_2 = \delta_0$ (indicating that RTs are equal during L1, L2 and L3 translation production task) and alternatively H_1: $\mu_1 - \mu_2 \neq \delta_0$ (indicating that RTs are not equal during L1, L2 and L3 translation production task). The results showed that RTs during translation production task in categorised lists of L1-L2 had statistically insignificantly longer RTs (1269 ± 193) compared to that in the randomised lists (1217 ± 204), t (127) = 1.82, p = 0.071. Similarly, in the in case of L1-L3 where the results showed that the RTs had statistically significantly longer RTs (1310 ± 212) compared to that in the randomised lists (1201 ± 225), t (127) = 3.50, p = 0.001.

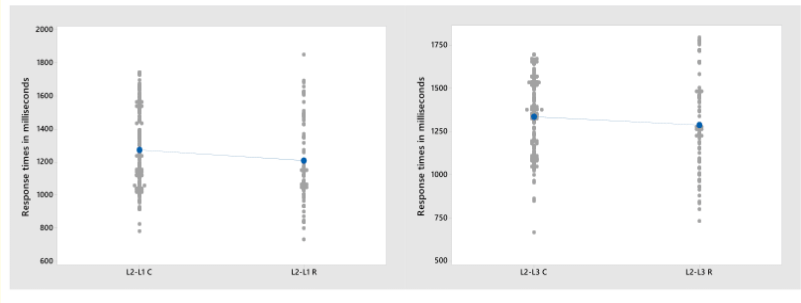

Figure 18: *The association between calculated response times during translation production task in L2-L1 and L2-L3.*

An independent t-test was run on a sample of 168 items (in each categorised list column) and 72 items (in each randomised list column) to determine if there were differences in response times RTs between L2 to L1 and L2 to L3 (categorised list) and L2 to L1 and L2 to L3 (randomised list) during translation production task based on categorised and randomised lists of words. Both groups (males and females) consisted of 20 multilinguals. It was hypothesised that H_0: $\mu_1 - \mu_2 = \delta_0$ (indicating that RTs are equal during L1, L2 and L3 translation production task) and alternatively H_1: $\mu_1 - \mu_2 \neq \delta_0$ (indicating that RTs are not equal during L1, L2 and L3 translation production task). The results showed that RTs during translation production task in categorised lists of L2-L1 had statistically insignificantly longer RTs (1274 ± 238) compared to that in the randomised lists (1209 ± 259), t (124) = 1.83, p = 0.070. Moreover, this seems to be the same in the case of L2-L3 where the results showed that the RTs had statistically but insignificantly longer RTs (1337 ± 213) compared to that in the randomised lists (1290 ± 272), t (110) = 1.31, p = 0.191.

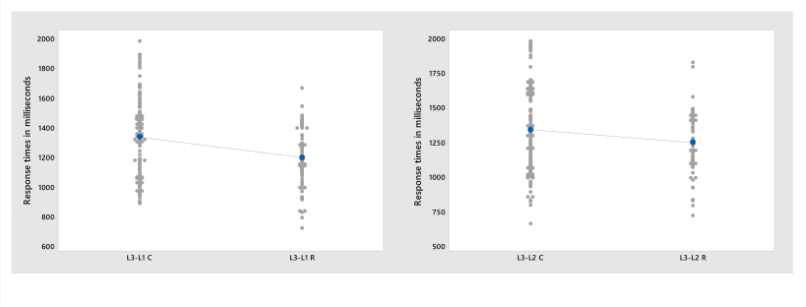

Figure 19: *The association between calculated response times during translation production task in L3-L1 and L3-L2.*

An independent t-test was run on a sample of 168 items (in each categorised list column) and 72 items (in each randomised list column) to determine if there were differences in response times RTs between L3 to L1 and L3 to L2 (categorised list) and L3 to L1 and L3 to L2 (randomised list) during translation production task based on categorised and randomised lists of words. Both groups (males and females) consisted of 20 multilinguals. It was hypothesised that H_0: $\mu_1 - \mu_2 = \delta_0$ (indicating that RTs are equal during L1, L2 and L3 translation production task) and alternatively H_1: $\mu_1 - \mu_2 \neq \delta_0$ (indicating that RTs are not equal during L1, L2 and L3 translation production task). The results showed that RTs during translation production task in categorised lists of L3-L1 had statistically significantly longer RTs (1344 ± 243) compared to that in the randomised lists (1206 ± 198), t (162) = 4.63, p = 0.000. Besides, this is also the same in the case of L3-L2 where the results showed that RTs had statistically significantly longer RTs (1350 ± 300) compared to that in the randomised lists (1257 ± 217), t (182) = 2.70, p = 0.008.

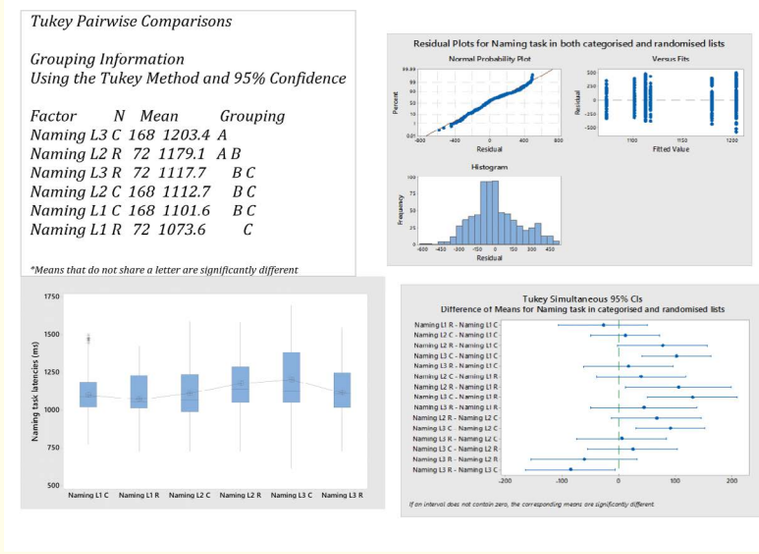

Figure 20: *Classification of the possible connections among L1, L2 and L3 through the calculated response times during naming task.*

A one-way ANOVA test was conducted to determine if RTs were different for multilinguals with categorised and randomised lists during naming task. Participants were 20 (males and females) and the data was classified into two main groups: naming (categorised list), naming (randomised list) where each was further classified into three subgroups (L1, L2 and L3) in each. There was a statistically significant difference between groups as determined by a one-way ANOVA, F (5.71) = 7.67, p = .000. The results of the Tukey's test are included in the grouping information table which highlights the significant and non-significant comparisons. Because only (L3 C) and (L1 R) are in different groups, not all other naming conditions have average RTs that are significantly different from each other. Furthermore, normal probability plot, histogram, versus fits and versus order graphs were generated to detect non-normality multiple peaks, outliers, non-normality non-constant variance and the time dependence of the residuals respectively. It is shown that the four-in-one residual plots indicated no violations of statistical assumptions. That is to say, no serious departure from normality was detected. The one-way ANOVA model fits the data relatively well. The boxplot indicates also that (Naming L1 categorised) with an asterisk (*) showed unusually different RTs. The Tukey 95% confidence interval plot was also generated to determine the likely ranges for the differences and to assess the practical significance of those differences. With reference to the dashed line at zero, if an interval does not contain zero, the corresponding means are significantly different. We can reach the point that not all naming condition have significantly different average RTs with the exception of five conditions as per illustrated in the interval plot.

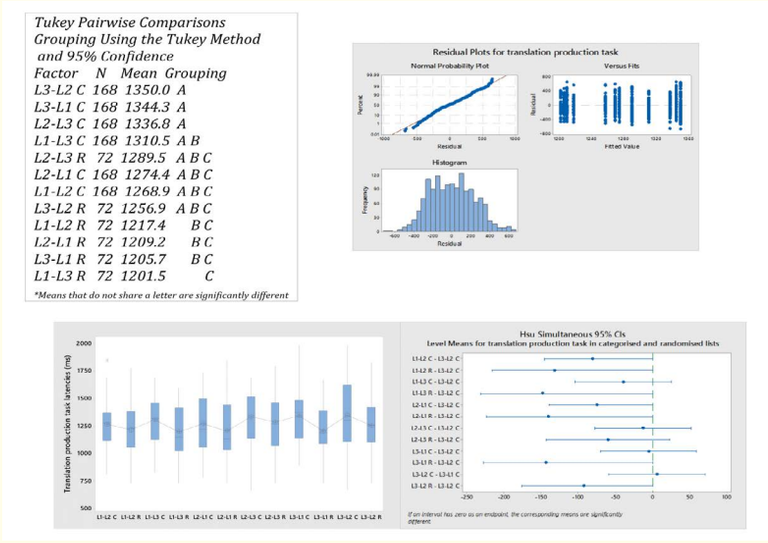

Figure 21: *Classification of the possible connections among L1, L2 and L3 through the calculated response times during translation production task.*

A one-way ANOVA test was also conducted to determine if RTs were different for multilinguals with categorised and randomised lists during translation production task. Participants were 20 (males and females) and the data was classified into two main groups: translation (categorised list), translation (randomised list) where each was further classified into six subgroups (L1-L2, L1-L3, L2-L1, L2-L3, L3-L1 and L3-L2) in each. There was a statistically significant difference between groups as determined by a one-way ANOVA, $F(11.14) = 6.07$, $p = .000$. The results of the Tukey's test are included in the grouping information table which highlights the significant and non-significant comparisons. Because only four conditions (L3-L2 C, L3-L1 C, L2-L3 and L1-L3 R) are in different groups, not all other naming conditions have average RTs that are significantly different from each other. Moreover, normal probability plot, histogram, versus fits and versus order graphs were generated to detect non-normality multiple peaks, outliers, non-normality non-constant variance and the time dependence of the residuals, respectively. It is shown that the four-in-one residual plots indicated no violations of statistical assumptions. That is to say, no serious departure from normality was detected. The one-way ANOVA model fits the data relatively well. The boxplot indicates also that (translation condition L1-L2 categorised) with an asterisk (*) showed unusually different RTs. The Hsu 95% confidence interval plot was also generated to determine the likely ranges for the differences and to assess the practical significance of those differences. With reference to the dashed line at zero, if an interval has a zero as an endpoint, the corresponding means are significantly different. We can reach the point that not all translation production task conditions have significantly different average RTs with the exception of seven conditions as per illustrated in the interval plot.

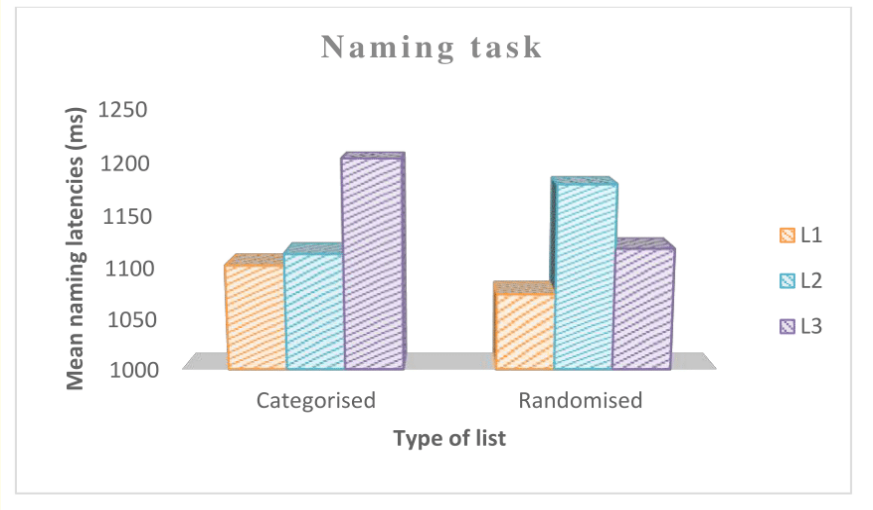

Figure 22: *Mean naming task latencies in milliseconds in categorised and randomised conditions for L1, L2 and L3.*

This graph was designed in order to determine whether RTs times were longer or shorter in the case of categorised or randomised lists during the naming task. According to this graph, the RTs were generally shorter in the case of randomised lists of words. However yet in comparison, RTs seem to be inconsistent i.e. shorter in L1 and L3 in the randomised lists than those of L1 and L3 in the categorised lists, but longer in L2 of the randomised list than in the categorised list of L2. By this means, the effect of categorised and randomised list seems not to be affecting RTs of multilinguals.

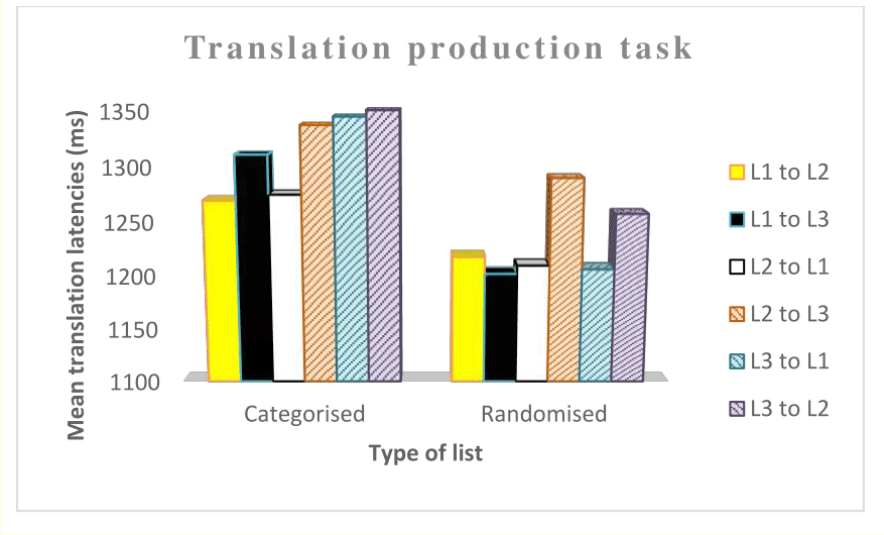

Figure 23: *Mean translation production task latencies in milliseconds in categorised and randomised conditions for L1, L2 and L3.*

This graph was designed in order to determine whether RTs times were longer or shorter in the case of categorised or randomised lists during translation production task. According to this graph, the RTs were generally longer in the case of categorised lists of words. Different to the naming task where the results were inconsistent, in the case of translation production tasks RTs were clearly longer with the use of categorised list of words. On the basis of this, one could conclude that RTs were significantly faster during translation production tasks with the use of randomised lists of words. Above all, this graph could give us an initial indication about the relationship in multilingual memory representation where it could be seen that the RTs in L1 to L2 and L1 to L3 were faster (except in the case of randomised lists). Similarly, RTs for L2 to L1 were faster than RTs for the translation of L2 to L3. Once again, the RTs were also faster during the translation of L3 to L1 than during the translation of L3 to L2.

Discussion

In our introductory section, we reviewed different bilingual memory representation models where some of which have been examined on multilingual memory representation e.g. MIA (Figure 11) and some have not been examined yet e.g. extended model of lexical and conceptual bilingual memory representation (Figure 4). The argument of bilingual memory representation has started with the view of having either coordinate relationship, compound relationship or subordinate one (Figure 1). A simulated model for this attempt was the three common hypotheses assuming associations between the two languages, concept mediations between the two languages, or both but the former in early proficiency level and the latter in the late and/or advanced proficiency level (Figure 2). On the basis of these three hypotheses, a number of models were introduced yet examined with the assumption of asymmetric interconnections between L1 and L2, rather than symmetric ones (Figure 3-4). The developmental model which was examined on both bilingual and multilingual memory representations was also presented based on strong proficiency and weak proficiency of the additional languages (Figures 5-6). Models assuming the integration and other models assuming the separation of bilingual memory representation and/or multilingual memory representation were also presented (Figure 7-11). In the results' section i.e. tables 10-12 and figures 12-23, we attempt establishing a model for multilingual memory representation. This establishment is mainly based on our presented data and its comparison to the earlier presented models and the reached results in regard to such models.

Proposed assumptions

In order to achieve this, we conducted an experiment including three tasks on 20 participants with L1 (Arabic or Turkish) and L2 (English or Turkish) and L3 (Turkish or English). These three tasks included: naming, translation production and incidental recall. With

naming, we aimed to measure the role of lexical level processing among L1, L2 and L3 assuming that RTs will be longer in L2 than in L1 due to the view that L2 lexicon is smaller and requires additional accessing time. Following this view, we assumed also that if L2 naming needs additional access time, then L3 naming needs more addition access time than that of L2 and normally L1. That is to say, L3 lexicon is smaller than those of L2 and L1.

And by the translation production task, we considered the view that that translation from L2 to L1 is faster than the translation from L1 to L2 (to be examined) and assumed that translation from L3 to L1 would be also faster than the translation from L1 to L3. We also assumed that the connections between the two additional languages will developmental-affected by proficiency and recency factors yet asymmetric-varies according to cognitive efforts and experienced conditions i.e. naming, picture-naming, translation, etc.. Finally, we also used the categorisation feature and assumed that categorisation interference will be effective only on conceptually-based conditions i.e. L1-L2 and L1-L3. That is to say, the other conditions will be equal in both categorised and randomised lists as they are lexically based.

By the recall task, we intended to approve that retrieval rate will be enhanced by the conceptually mediated conditions (if they really are) i.e. L2-L1, L3-1, L2-L3 and L3-2. We assume that the recall will be better in these last conditions than in the L1-L2 and L1-3 conditions which are lexically based.

Incidental recall task

To start with the incidental recall task, our results indicated that the retrieval rate of recall was generally higher for L1 than those of L2 and L3 (Ms = 7.57, 6.50, SD = 2.27, 1.52) be it in categorised or randomised conditions. Moreover, the retrieval rate of recall in L2 was higher than that of L3 but only in the categorised condition (M = 6.85, SD = 2.03) compared to only (M = 6.00, SD = 2.22) (see table 11). In spite of these differences, they were all statistically insignificant as P-value was higher than .05 (see figure 12). By this means, we could assume that category interference didn't affect recall after naming tasks in L1, L2 and L3 though relatively variable means were calculated.

However, the results seem to be different in the case of incidental recall after the translation production task. Generally speaking, there were no statistically significant difference among the retrieval rate of recall in the six conditions of categorised translation and six conditions of randomised translation for L1, L2 and L3 as the results showed that P-values were greater than .05 (see figure 13-15). Yet, the retrieval rate of recall for L1 was relatively higher than those of L2 and L3 in the case of categorised lists. On the other hand, it was higher for L2 than L1 and L3 and for L3 than L1. Therefore yet among the recorded rates of recall, the exact similarities were only recorded in the conditions where the source language is an additional language, that is L2-L1 and L2-3 (in the categorised conditions) and L3-L1 and L3-L2 (in the categorised conditions also) and L2-L1 and L2-L3 (in the randomised conditions).

Response times (RTs) during naming and translation production tasks

As we have mentioned in the method section (see table 7), our study is mainly based on the recorded RTs. We will start with reviewing the RTs of naming tasks. There were six conditions of naming three for the categorised lists and three for the randomised lists in L1, L2 and L3. The shortest recorded RT during naming was 613 (for naming L3 categorised) and the longest RT was 1698-suprisngly for the same condition. Our discussion will be based on the mean latencies of naming in milliseconds (ms). In general yet as expected, naming times in L1 were shorter than naming times in L2 and L3 in both the categorised and randomised conditions. The difference was nearly 11 ms between L1 and L2 and 102 ms between L1 and L3 in the categorised lists and only 6 ms between L1 and L2 and 44 ms between L1 and L3 in the randomised lists. Moreover yet comparatively, the naming times in L2 were shorter than the naming times in L3 for the categorised lists but longer than L3 naming times in the randomised lists. By this means and with reference to (figure 16), we can reach the view that categorisation didn't affect the rate of naming times during L1 but it was significant in the case of L2 and L3. The view that additional languages i.e. L2 and L3 here-have smaller lexicon(s) seems to be applicable as the naming times were shorter. Furthermore, whether the L2 lexicon is smaller or larger than the L3 lexicon was not clearly identified as the naming times were shorter for L2 than L3 in the categorised lists but longer than L3 naming times in the randomised lists. This might become clearer after we reach some conclusions in regard to the translation times of such conditions.

In the translation production task, there were 12 conditions: six for the categorised conditions and six for the randomised conditions (see table 9). The shortest RT was recorded for L2-L3 (categorised) as 667 and the longest RT was recorded for L3-L2 condition (categorised) as 1988. However and as we have already mentioned that our discussion will be based on the mean latencies in ms. In comparison between naming and translation times, the two are considerably different. The difference between naming times and translation times was approximately was 277 ms (see table 12). While translation times in L1-L2 were shorter than L1-L3 in the categorised list, they were longer in randomised list. Yet, these differences were statistically significant only in the randomised list when comparing both the categorised and randomised conditions (see figure 17). Similarly, the translation times for L2-L1 in the categorised list were shorter than the translation times for L2-L3 (statistically significant when compared to that of the categorised list), whereas those in the randomised list for L2-L1 were slightly shorter than the RTs for L2-L3 (statistically insignificant when compared to that of the categorised list) (see figure 18). Additionally, the translation times for L3-L1 and L3-L2 in the categorised list were relatively similar. The difference between the conditions was probably not more than 5 ms. Dissimilar to this, the difference between the two conditions in the randomised list was about 51 ms in favour of L3-L1. When comparing the categorisation effect with reference to (Figures 16-19), it could be seen that the translation times were different with a statistical significance in the conditions: L1-L3, L1-L3 (categorised vs. randomised) and all L3 conditions i.e. L3-L1, L3-1 (categorised vs. randomised) and L3-L2 and L3-L2 (categorised vs. randomised) (these inferences were also verified with the ANOVA results in figures 20 and 21). The conditions L1-L2, L1-L2, L2-L1 and L2-L3 (categorised vs. randomised) in each didn't achieve a statistically significant difference. It was assumed that categorisation will affect languages or lexicons which are conceptually mediated namely L1-L2 and L1-L3 but not the lexically based ones i.e. L2-L1, L2-L3, and L3-L1 and L3-L2. This assumption was achieved in the case of L2, but not in the case of L3 which gives us an indication that the types of association of L3 lexicon seem to be different from those of L2 lexicon. Besides, the effect of categorisation was also significant in the case L1-L3 which is also supposed to be conceptually mediated [if really L1-L2 is conceptually mediated].

Possible explanations for the output

More specifically and with reference to (Figure 22), naming times were significantly longer in L3 than L1 yet slightly longer in L2 than L1 in the categorised lists. The same results were also found in the case of the randomised lists with only one difference where L2 but not L3 showed longer RTs. We attribute this to phonological retrieval of the additional languages. The serial order, that is having longer RTs in L3 than those in L2 supports this view that the phonological proficiency is higher in L2 than that in L3 which has been being recently acquired. The need to think of the right phonological and phonetic output causes for longer latencies, a thing which is not applicable on the L1 where the phonological retrieval happens automatically and the interaction between neural networks, visual networks and physiological ones is used to such system which was acquired since the early birth moments. In order to investigate these results further, we went back to the collected data through the language history questionnaire and matched this to the collected RTs along with the replication forms (see the appendix for these forms). We reached the point that since L3 was either Turkish for the Arab participants or Arabic for the Turkish participants, it was somehow logical to reach such results. That is to say, for Arabs Turkish being the recent yet ongoing acquired/learned languages so such latencies are longer affected by proficiency level i.e. phonological one. As the same time, for Turkish participants, having Arabic as L3, the recent language yet the one with different orthographic system different from that they are used to with the Latin script, it was also to have such longer RTs for L3 naming. We also to attribute the precedence of L2 RTs to the high proficiency level of L2 be it for Turkish or Arab participants. In the case of the randomised lists where L3 RTs were shorter than those of L2, this is attributed to the effect of cognate words (see the appendix). While having some cognate words in the three languages, there was also a list called (nationalities), all together-we contributed to have the participants say sometimes the words closer to Turkish than to than English, both Arabs and Turkish participants. The mother tongue interference and dominance was clear in the case of Turkish participants. On the other hand, the recency effect, that is using the pronunciation of the language being used most (Turkish since they were residing in Turkey) caused to prolonging the production time in the neural network though visually processed true.

Earlier literature supporting the conceptual and lexical connections in bilingual memory representation (see figure 4) reached that the translations times in L1-L2 will be longer than those in L2-L1 as the former is conceptually based and the latter is lexically based.

Conceptual mediation access requires more time a step which is in included and required in the lexical based tasks. Our results (see figure 23) showed that difference between the translation times in L1-L2 and L2-L1 was about 6 ms in favour of the former. Therefore, this doesn't support the earlier views. However, this view was observed in the case of the randomised list where the translation times of L2-L1 were slightly shorter than those of L1-L2. The difference was about 8 ms. By this means, the conceptual mediation model was applicable on the randomised list but not in the categorised list. Having this in mind, we also wanted to see if this view was applicable to L1-L3 and L3-L1. The results indicated that translation times were about 34 ms shorter for the former. This is again support the view that conceptual mediation neither in L1-L2 nor in L1-L3 is conceptually mediated while using categorised lists. The translation times' difference was shorter in the randomised list. However, it was again shorter for L1-L3, other than L3-L1 as proposed in the conceptual mediation and lexical model.

Having these assumptions in mind, we wanted also to examine the possible relationship(s) between L2-L3 and L3-L2 in both the categorised and randomised lists. The translation times were approximately 14 ms shorter for L2-L3 in the categorised lists. On the contrary, it was about 33 ms shorter for L3-L2 in the randomised lists. Would this mean that the translation production was conceptually mediated in the case of the categorised lists but in the case of the randomised lists? Would it mean that they both yet as additional languages— are lexically based and the relationship between them is developmental i.e. based on proficiency level and maybe affected by other factor e.g. recency etc.?

Summary

Incidental recall task after the naming task:

1. Retrieval rate of L1 was higher than those of L2 and L3 be in the categorised or randomised lists;
2. Retrieval rate of L2 was higher than that of L3 in the categorised lists but not in the randomised lists; and
3. Generally more words were recalled in the categorised lists in L1, L2 and L3 though statistically insignificant differences.

Incidental recall task after the translation production task:

1. Retrieval rates after L1-L2 and L1-L3 translations were higher than those of L2-L1 and L3-L1 in the categorised lists but not in the same randomised list where they were less;
2. Retrieval rates were higher after L2-L3 translation than those after L3-L2 in both the categorised and randomised lists; and
3. In general the retrieval rates were higher in the randomised lists though more words were recalled in the categorised lists 11/12 for the latter as compared to 10/12 in the former (the highest recalled lists by participants).

General summary

1. The retrieval rate after naming task was insignificantly higher than that after the translation production task in the categorised lists (286 recalled words) for the former as compared to only (279) for the latter;
2. The retrieval rate after the naming task less than that after the translation production task in the randomised list (115) for the former as compared to (127) for the latter; and
3. There was no significant differences in the retrieval rates after the naming and translation tasks with the exception of that in L1-L2 and L1-L3 in the categorised lists where 11/12 words were recalled by some participants as compared to 10/12 in the randomised lists.

Naming task

1. Naming times were different among the L1, L2 and L3 be it in the categorised or randomised lists though some of these differences were statistically insignificant;
2. L1 has generally shorter naming times than those of L2 and L3 in both the categorised and randomised lists;

3. Naming times were generally shorter in the categorised lists except for L3 where they were longer in the categorised lists; and
4. While L2 naming times were shorter than L3 naming times in the categorised lists, they were surprisingly longer in the randomised lists.

General summary:

1. Since the L1 naming times were the shortest in the both the categorised and randomised lists, so L1 lexicon according to these results is assumed to be the largest;
2. Since the naming times of L1 were shorter that those of L2 and L3 in both the categorised and randomised list, so the lexicons of L2 and L3 are assumed to be generally smaller than that of L1; and
3. Furthermore, since the naming times of L2 and L3 were variant in the categorised and randomised lists, so the size of lexicon(s) of the additional languages are asymmetric. In other words, access of the lexicon(s) is affected by cognitive factors i.e. categorisation (as in our study). The categorised lists showed L3 lexicon as the smallest (taking the longest RTs after naming), but the randomised list showed L2 as the smallest lexicon (taking again the longest RTs after naming).

Translation production task

1. The RTs of translation from L1 to L2 and L1 to L3 were generally shorter than those from L2 to L1, L2 to L3, L3 to L1 and L3 to L2 in the categorised lists but not in the randomised lists where they were longer in the case of L1 to L2 than L2 to L1 and L3 to L1, yet statistically insignificant;
2. The RTs of the translation from L2 to L1 were insignificantly longer than the RTs L1 to L2 in the categorised lists but yet again insignificantly [shorter] in the randomised lists;
3. The RTs of the translation from L3 to L1 were significantly longer than those of L1 to L3 in the categorised lists but insignificantly shorter in the randomised lists;
4. While the RTs of the translation from L1 to L2 were significantly shorter than those of the L1 to L3 in the categorised lists, they were insignificantly longer in the randomised lists; and
5. The RTs of L2 to L3 were insignificantly shorter than those of L3 to L2 (14 ms difference) in the categorised lists. On the other hand, the RTs of L2 to L3 were also insignificantly longer than those of L3 to L2 (33 ms difference) in the randomised lists.

Categorisation interference

1. The RTs of both L1 to L2 and L1 to L3 were significantly longer in the categorised lists than those in the randomised lists;
2. The RTs of both L2 to L1 and L3 to L1 were significantly longer in the categorised lists than those of the randomised lists; and
3. The RTs of both L2 to L3 and L3 to L2 were significantly longer in the categorised lists than those of the randomised lists.

RTs of the naming the translation production tasks

1. The RTs of the naming task were generally shorter than the RTs of the translation production task in both the categorised and randomised lists.

Conclusions

We conducted a study examining the multilingual memory representation where 20 multilinguals took part in the study. The study was carried out in the Language Lab, Department of Linguistics, Ankara University, Ankara, Turkey. Moreover, the study was designed using the SuperLab version 5 where in three tasks were used namely: incidental recall, naming and translation production. The three examined languages included: Arabic, English and Turkish where Arabic was either as L1 for some participants or as L3 for some others, and Turkish was as L3 for some participants or as L1 for some others. English was almost functioning as L2 for all the participants. A list of 144 words-divided into 12 categories (12 x 12= 144) was used. Furthermore, two types of lists were used categorised and randomised

lists. The total average time for each participant was 25 minutes including that for filling in the language history questionnaire and the introductory explanation to the experiment. Each participant was set on the experimental room and the researcher in the Lab room. While the recalled words were noted down by each participant after both naming and translation tasks, the RTs were automatically recorded during both the naming and translation production tasks. Therefore, our main purpose was to examine claim supporting the view that translation from L2 to L1 is faster than translation from L1 to L2 due to the fact that the former is lexically based and the latter is conceptually based. In other words, because conceptual access requires more cognitive efforts so more time will be required causing the translation from L1 to L2 to be slower than the translation from L2 to L1 which requires only lexical access-taking normally shorter time to be performed! Having this in mind, we also wanted to examine the status of L3 compared to those of L1 and L2. Our results indicated that the RTs of the naming task were generally shorter than those of the translation production task in the categorised and randomised lists of L1, L2 and L3. This matches the view that the conceptual access is not required while naming-resulting into faster naming times as compared to picture naming or translation which require conceptual access. Additionally, the RTs of translation from L1 to L2 and L1 to L3 were shorter than those from L2 to L1 and L3 to L1 contradicting the view that it would be vice versa. However, the view that it would be so was true in the case of randomised lists where the RTs were shorter for L2 to L1 and L3 to L1 than those of L1 to L2 and L1 to L3. By this means we assume that the representation of multilingual memory seems to be developmental other than that assuming lexical or conceptual. Besides, the RTs of L2 to L3 were insignificantly shorter than those of L3 to L2 (14 ms difference) in the categorised lists. On the other hand, the RTs of L2 to L3 were also insignificantly longer than those of L3 to L2 (33 ms difference) in the randomised lists. Again, this indicates again that neither the word association nor the concept mediation hypotheses are consistent with our output; the developmental hypotheses assuming variability and influence of dominance language is more consistent to our output. Additionally, there were no consistency and or equal RTs as assumed that categorisation will interfere in the translation from L1 to L2 or L1 to L3. In terms of the naming tasks, our data predicts through the differences among the recorded RTs that the size of lexicon is variable starting from L1 as the largest and L2 and L3 which are variable affected by categorisation which showed L2 as the smallest when using randomised lists and L3 as the smallest lexicon when using categorised lists. Finally, in the incidental recall task, it was found that the retrieval rate was higher after the naming tasks when using categorised lists but it was higher after the translation task when using the randomised lists. This supports the view that categorisation could play the role of either facilitation or interference. In our study, categorisation supported the incidental recall to overcome that of translation. At the same time, it resulted to less retrieval rate after translation. The conceptual access which was activated during translation and with the absence of categorisation in the randomised lists resulted into more retrieval rate after translation.

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