COGNITIVE SYSTEMS EVOLUTION: IMMIGRANT LAST GENERATIONS AND COGNITIVE MAPPING CHANGING

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Abstract- There is little evidence on the correlation between immigration effects and the evolution of the mind and cognition, especially concerning children. Last generations of young immigrants are expected to experience adaptive strategies to respond to the school environment in order to achieve success. Specifically concerning the new language learning in the diversity of the host countries (plus the diversity of the countries of origin and home languages/cultures), it should be analyzed how the human cognitive aptitude (language aptitude and problem solving) is being reorganized in terms of thought, concepts and cultural orientations previously developed in a certain native culture. The native culture (aspects of the nationality and of the home language) is mentally associated to concepts and generates the self-regulation which implies consciousness in a home culture as a reference. How does it works for new immigrants that were separated (including cases of forced immigration) from their unique cognitive reference? Different cognitive achievements and language deficits would be constrained in their natural development and differences in academic achievement are expected. This lead to implications for the biological hypothesis of critical period concerning the new waves of immigration and ethnic differentiation in current generations. Age would be considered along with other unexpected variables such as nationality. The present study examines populations' differences – ethnic and age – on specific language and cognitive tasks considering immigrant students in Portuguese schools (M=13 years old; SD= 2,7) with origin in different world areas: Western Europe, Eastern Europe, African countries, Latin America, Asia (Indian Asia) and China and with different home languages and cultures. Data showed a variability of groups' achievements in cognates, text recall, lexical recall and dichotic listening tasks. Disparities among the minorities will be discussed considering educational and ethological implications. Population evolutionary characteristics might be concluded from those disparities.

Keywords- Cognitive Mapping, Second Language, Immigration, School Population, Critical period hypothesis.

I. INTRODUCTION

Besides neurosciences and the Cognitive Psychology, also Evolutionary Anthropology has devoted investigation about the brain of second language learners of the current generation. It is well known that the brain is changing because is part of the evolutionary human process. On the other hand, fewer evidence exists about the languages learning and the fast processing, demanded by cultures and geographic constraints,that might be operating as a contribute for the prediction of new adaptive behaviors [1]. The study of language is the basis to understand the refinement of human mental abilities during time [2]. In a study [3] recently developed, an analysis of 60 years of research on the theme of neural plasticity was provided, in the scope of chemistry upmost, addressing high skills related such as the language faculty. In this period of research and its insights on the plasticity we found that it appears that lack of consensus specifically regarding the language period hypothesis would be related to the evolution of cognitive brain system that was already changed in a continuous process. That change is hypothesized in the present paper as the result of languages learning of the last decades that demand high cognitive processing strategies to the generations' brains. Different languages, not limited to the English as L2, involved new unexplored

cognitive functioning that is inherited, within the concept of language inheritance, to the next generation. Computational science revealed recent advances that explain cross-linguistic competence enhanced by different language speakers when they are in a second language learning context or bilingual experienced [4]. Competitions models for lexicon ability are frequently tested in order to understand how the *brains* struggles in languages other than English and which consequences are possible [5]. Attached to this evidence, tasks recently are tested to verify their power for measuring proficiency because individuals are differently responding to the same tasks that were applied decades ago. Is this the case of cognates that are recently verified as displaying more costs than facilitating effect for learners during a cognates decoding activity [5].

In this study we present results concerning specific tasks that we have administered to 108 Portuguese immigrant children with previous instruction - cognates test, text recall, words recall and dichotic listening test - to test the following hypotheses:

H1: The age variable remains as main argument to explain the performance differences in cognitive tasks: children are expected to outperform the older students in the same tasks;
H2: The nationality is a new variable to be considered as argument for cognitive differences inferred from

cognitive and language tasks: it is expected non random distribution of scores between groups in the same tasks.

Implications regarding the critical period hypothesis will be discussed as well educational implications from cognitive differences observed among groups for each task of the study trial.

II. DETAILS EXPERIMENTAL

2.1. Sample

We tested 108 participants immigrated in Portugal aged between 7 and 18 years of age (M= 13; SD= 2,7), from 2nd to 12th grades. 25 (23%) Chinese, 6 (6%) Hispanic, 31 (29%) Russian and Ukrainian, 19 (18%) African, 12 (11%) Occidentals (Europe), and 14 (13%) Asian (other than China). These 108 young students are placed in different 11 Portuguese schools since their arrival, in Lisbon metropolitan area, where they are examined by answering to the tests of this study. Participants speak different home languages: Mandarin, Romance languages, Slavic languages Portuguese-based creole, Indo-Aryan languages and Arabic. The participants has a Length of Residence ranging between 3 years and few months considering the date of testing (mean = 2009 (4 years); SD; 2,9). Length of Residence and age (age considering the time of the empirical study) were correlated and there were no significant differences. The homogeneity and normality of the sample were examined trough the Levene and Shapiro-Wilk tests.

2.2. Instrument

Cognates Awareness Test

The Cognates Test is composed of 5 items and was adapted from the *Cognates Awareness Test* [6]. The Portuguese adapted version has a Cronbach's alpha of .70 (the same reliability value as the original test). The test aims, within verbal reasoning, to assess how students whose mother tongue is not Portuguese, decode the meaning of a list of words (in Portuguese) that have cognates across the Portuguese as target language and the L1 of the tested learner. It is expected that romance languages such as Spanish, French and Catalan have more cognates within the Portuguese, so speakers of those language will be able to identify the cognates easier (hypothesis). The cognates' task aims to measure the decoding skills of cognates as a source for the transfer between L1 and L2. This is a list of words with options whereby only one answer that should be the correct meaning of the requested word is to be selected. For example, there are words that are called "false friends" because they have visual similarity (lexical) but are distant in terms of meaning (phonology and semantics). This kind of similarity is the main distractor in cognates' tests. The test scores follow the original scoring of this test: 1 point for each correct answer (total score: 5 points), 0 for incorrect answers.

Lexical Recall

This recall test was developed specifically to evaluate the attention capacity and memory of non-native students to remember in writing as many words as possible, as well as the story with ordered facts, after listeningone short story in Portuguese as L2. The sound file was allowed to be listened only once. The intention is to ascertain how distinct groups with different home languages and ages behave in this test considering that besides the memory and attention tasks, they have the added effort that the test is in a language in which they are barely proficient. Only the words correctly recalled and the facts correctly or partially ordered were considered (minimum 1 word identified correctly).

Text Recall

The recall test was created for this set of tests in order to assess the attention capacity and memory of non-native students to remember in writing as many words as possible, as well as the story with ordered facts, after reading three short texts of different literary works in Portuguese listed in the Basic and Secondary education curriculum. The texts are taken away after having been read and students were instructed on the test procedure. The intention is to ascertain how distinct groups (L1) with different nationalities behave in this test considering that besides the memory and attention tasks, they have the added effort that the test is in a language in which they are barely proficient. Only the words correctly recalled and the facts correctly or partially ordered were considered (minimum 1 event identified correctly). Two points were allocated to complete answers, 1 point to each correctly registered item, 1 point to partially correctly answers, 0 points given to incorrect answers or no response.

All the tests were administered in the classroom, during spaced intervals (classroom prepared for the effect) and mostly in group sessions where the instructions for each task were informed. The study was developed between 2013 and 2016 and additional measures (tests battery) were also administered along with the recall and cognates tasks. Paper and computer were used and all the authorization procedures were completed (school directors, teachers and the students' parents were informed about the project goals).

III. RESULTS AND DISCUSSION

3.1. Hypothesis 1: Critical period and age

Descriptive statistics concerning mean differences for the groups of age/nationality/home language are displayed in Table 1. We used a serie of univariate ANOVAs (two-factor analysis for each trial of this study) to complete the hypothesis testing and was observed that for **cognates** test there were no significant differences among age groups, neither for

the other variables. For the **text recall**(F 2,918; *p*= .038; η2 .083) and **lexicalrecall**[F 2,456; *p*= .050; η2.083) age revealed to have influence in achievement. Means, standard deviations, *Tukey* tests and *eta* squared values (η2) were calculated to determine differences and effect size. Youngest participants (aged between 7-9) had the lowest scores in recall tests (M= 2,50; M= 4,30, respectively for lexical and text recall) compared to adolescents (aged 13 and 18) with higher scores (M= 4,85; M= 10,66, respectively). The *post hoc* tests revealed main statistical (*p*< .05) differences between the younger children (7-9) and the 13-15 pre-pubescents (Table 1).

Specifically regarding the **dichotic listening** task, we concluded that groups behave differently in the results obtained considering also the age independent variable (F 2,524; *p*= .042). The youngest learners (7-9 years old) had the poorest decoding in register the real words listened (M= 0,20) against the group of 13-15 years old (M= 0,87). The absence of significant statistical differences for nonwords identification or 'conversion' (decoding a nonword as a real word by detecting lexical and phonetics similarities) among the several age groups is a indicator of the same level of decoding accuracy. However, the all groups had lower performance in this task (Table 1).

Table 1. Descriptive statistics for second language learners reported performance on recall tests (recall of words and texts) according to age

Task	Age Groups	Mean	F	Sig.	η2
Lexical Recall	7-9*	4,30	2,456	050	083
	10 12	9,18			
	13-15	10,66			
	16 18*	12,79			
Text Recall	7-9*	2,50	2,918	.038	.082
	10-12	4,38			
	13-15*	4,85			
	16-18	3,82			
Dichotic Listening		0,20	2,524	.042	.081
	7-9*	0,79			
	10-12	0,87			
	13-15*				
	16-18	0,75			

*significant difference at p< .05

Because age is frequently the argument for the critical period hypothesis our interest is to observe how young learners behave in tasks supposed as having more difficulty in terms of cognitive complexity (such as cognates), expecting differences (*p* value) between youngest and oldest participants. The hypothesis 1 was partially rejected. On one hand, there was no difference for cognates task against past and recent data from studies that argued more accuracy gathered from the use of cognates tests [7] [8][9], mainly addressing the adult population. Those studies specifically revealed advantage of cognates test for youngest learners as a facilitation effect. This effect depending completely on the proficiency of the individual in the languages taken as the basis for the cognates list. However, in the present study neither younger learners showed distinct scores from their older peers, neither home language proficiency emerged as a predictor (it was expected that romance language speakers – Hispanics and Occidental Europeans – would benefit from the cognates task contrasting with the other speakers of distant languages [10]. No significant differences were achieved for the L1 variable in the cognates test. The referred facilitation effect did not fit for the Portuguese second language learners. This evidence might be reasonable for other languages as a L2 context. Additionally, the cognates tasks, as developmental and linguistic exercises, might present less 'cognitive' advantages than noncognates tasks [12].The overlapping suggested by cognates decoding could be treated as a distrator for the early beginners in a L2.

On the other hand, differences were concluded for recall tests(text recall and words recall), even considering the dichotic listening test (adolescents showed higher mean in words decoding).Attention and memory are expected more accurate in children for the language tasks when compared to adolescents, according to the critical period hypothesis [11] [13]. However our data showed a contrast that reduces the masterity of language commonly attributed to children. Also our data is consistent with other previous studies that had initiated a review in the critical period hypothesis by highlighting the misunderstanding on the older learners' capacity [14]. The similar scores verified for children and older students in language tasks is an evidence of the more recent studies. This fact might be related to the cognitive mapping changing as resulting from the immigration and language experience of recent populations mainly since 1960s. That 'cognitive changing' demands other review in the critical period hypothesis concerning that brain systems are changing due to a *memory of inheritance* of language features and language procedures.

Consistent past research has shown that the recall based on a second language is harder when compared to the recall based on native language [15], but fewer studies focused the difference between recall ability in L2 by comparing young children and adolescents. However, we haveevidence [16] that learners benefit

more, in vocabulary acquisition, from exercises other than reading/recall of texts. It is assumed that in recall tasks children are better when they are recalling by association (of words and ideas), more than when they are recalling dissociated information. This study is in accordance with our data considering that groups differed more significantly (p< .05) in text recall and that was not the case for lexical recall (this last task refers to the decoding of words and not to sentences or passages of one or more texts related in meaning). Some words of our word list recall, as well in the text recall, appeared intentionally in subsequent tasks which is an important variable functioning as predictor for achievement in this type of tasks: incidental and intentional vocabulary learning [17]. Incidental or intentional learning are positioned in the same theoretical background of attention and awareness as crucial skills to determine recognition and the 'detection' [18]. Detection is the capacity that requires high level of awareness which is greatly related to the dichotic hearing task in this study.

In the dichothic listening, children and adolescents did not show higher scores, on the contrary, the words recalled as real words are fewer than expected for the older children. Dichotic or *fused words* tasks are more related to attention demands (besides the role of working memory, [19]) and children were expected to have positive achievement in this task [20] but age advance is correlated to the right ear advantage which is explained by the brain maturation [21]. This was replicated in our study, suggesting a congruency of the full (*corpus*) data presented in this paper that sheds light on an incongruence of the critical period theory and, on the other hand, highlights the advantage of older children (second language learners). That incongruence is explained by the lack on the understanding of the cultural (as meaning, the home language) variable role for cognitive system. Current research is evolving to understand, through the dichotic listening tasks, that gap about the cultural influence for the right ear advantage as the main result and proof concerning the hemispheric lateralization [22].

The dichotic task also provides data that reflects one of the awareness levels discussed by authors like Robinson [23]: capacity of "simple detection" which corresponds to a low level of awareness, explicitly different from the noticing behavior in language [24]. Recent studies maintain the principle that *noticing hypothesis* is the most important for L2 learning [25]. Other evidence confirms that implicit and incidental (not depending from formal instruction) learning/acquisition are involved in every recall operation of second language learners (Williams, 1999). This conclusion contrasts the beginning of the theory framework of Krashen [26] that diminishes the role of implicit learning for the L2 full development. At least, and according to a similar international

study, for the recall tests it seems [27] that the good readers (with prior knowledge of reading skills and aware of syntactic complexity) have advantage in attaining higher levels of decoding during the recall task processing.

3.2. Hypothesis 2: Critical period and nationality variable

Series of univariate analyses of variance examined how different would be the nationality groups (from several continents, see above section 2.1.) performing the same tasks of verbal reasoning and language decoding (cognates) and of recall (text and lexical recall; dichotic listening). Results concluded that nationality groups did show differences in a significant manner: for **text recall** (F 4,129; *p*= .002; η2 .205) Chinese learners (M= 2,76 words recalled) were the poorest performers in this attention and memory test when compared (p > .05) to the Occidental Europe (M= 5,70) and Hispanics (M = 7,00 words); for the **lexical recall**, nation groups did not show significant differences; and for the **dichotic listening task** groups decoded differently (F 2,730; *p*= .025; η2 .141), Europeans showed means significantly different from Chinese and Asian young learners. See Table 2.

Table 2. Descriptive statistics for second language learners' reported performance on recall tests according to nationality

Task	Nationality Groups	Mean	F	Sig	η2
Text Recall	Chinese*	2,76	2,456	.050	.083
	Hispanics*	7,00			
	Russians /Ukrainians	4,36			
	Africans	4,53			
	Euro. Occid *	5,70			
	Asian	3,58	4,124	.002	.205
Dichotic Listening	Chinese*	0,54			
	Hispanics	0,80			
	Russians /Ukrainians	0,70			
	Africans	0,82	2,730	.025	.141
	Euro. Occid *	0,36			
	Asia*	0,50			

*significant difference at p< .05

The Hypothesis 2 was confirmed. Data showed that nationality groups decode in different manner, verified in 2 of 3 tasks. They revealed improved attention and memory for texts but not for words

considering that the lexical recall test displayed no significant differences between groups. This result maintained the assumption of Laufer [16] and Robinson 23] that determines the facilitation of recalling information by association (association of words or texts by form and meaning) which involve memory and attention cues. The nationality groups' distinction includes the assumption of existing different home languages – different lexical *corpora*– which explain how the text units, compared to isolated words or Word units, could be easier to detect once there is the events (meaning) sequence related. Additionally, for the dichotic listening task, the groups differed with low achievement for Asian and Chinese students which failure might be,again,explained by the distant orthographies that those learners have as their prior knowledge. For both tasks' differences, Chinese students were the poorest performers but in a previous study we had observed the outstanding accuracy of this specific group (identified in the study as the Mandarin Speakers) in other tasks such as the verbal analogies [10].

Shum, Ki and Leong [29] previously showed the masterity of *mandarin speaker's brain*in tasks demanding verbal reasoning features (such as the verbal analogy test) and proved, on the other hand, that Mandarin Speakers had problems to decode phonological information that appears in stimulus sequence different from the native 'habit' (which pressuposes a neural system associated by experience and adaptative behavior to encode and recognize sequences) in their home language. So, the words and isolated sounds recall would be likely a gap for the Chinese early L2 beginners in languages such as Portuguese. These cognitive (memory and attention) indicators from this specific trial study (students were instructed regarding each task during the assessment period) are explained by ethnic and nationality differences which was not expected according to the evidence of previous analyses [30] that outline race and ethnicity as not predictors of cognitive differences.However we believe that these groups' specificities are able to determine cognitive differences – neural or brain structure based - as well is well-known that those differences explain other behaviours – in the same neural basis argument - besides the cognition [31]. Along the cognitive or neural structure factor, we argue that the present data is based also in the educational type factor – the culture and resources of instruction - that students recently experienced in their countries of origin. The cognitive processing in these recall tasks might be biased also considering other factor: the parents' vocabulary and language used at home [33]. This topic should be further examined in similar studies to understand more factors that explain cognitive processing differences and recall abilities.

CONCLUSIONS

In sum, it seems that cognitive functions might distinctively be affected due to language constraints and being aware that neurobiological predisposition changes are modifying the understanding of the children advantage for non native languages. These children are identified as the recent immigrant' generation. Memory and attention as broad cognitive skills (for visual and for auditory *stimulus*) might be more constrained than lexical decoding (refering to a specific language 'neural device' only, [32]) regarding brain mechanisms. These data suggests that the language device probably was changed and likelyimproved, in terms of the executive functions refinement, in the last decades and the significant differences between younger and older immigrant learners (considering their condition as second language learners) are not the same evidence as verified in the 1960s [13]. This study contributes to a new evidence that highlights:

1. Critical period effect for language acquisition, applying to the L2 context, should consider a cognitive system change resulting from the immigration and languages learning experience. This experience since the last five decades (since the introduction of the critical period hypothesis, [13]) might determine changes in neural system that reflects advantages for linguistic and reasoning solving skills and also shortened the distance between age groups. In almost cases, children revealed in this study no differences in cognitive performance when compared with adolescents – contrasting the principle of the critical period. The last group – pre-pubescents - outperform young children in recall tests;
2. Nationality groups' differences in attention and memory tests might be due to prior knowledge and experience with different educational instruction (affecting cognitive processing strategies);
3. Further examination is encouraged by using similar tests as well and by replicating in the new generation of immigrants the same accurate tests developed for the initial second language learners' populations.

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