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The Empowerment of DMDX Language Technology in Neurolinguistics: Reaction Time and Accuracy

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Abstract:

DMDX is a very powerful language technique. It has been used for many research areas such psychology and speech pathology. Due to the flexibility of the technique, it can be used in many domains such as linguistics, more particularly in Neurolinguistics. The aim of the paper is to explore how to use DMDX language technique in the field of Neurolinguistics. An experiment of semantic un-related (SUR) in Arabic language was conducted. The paper focused on the technique employed in Arabic language system of DMDX. The system consists of 200 lexical items in Arabic language and 200 lexical items in English language. The first language emerged on the screen is the prime one, Arabic language and the second one emerged on the screen is the target one, English language. For both languages, the lists of lexical units were structured based on noun category and based on the types of nouns in both languages. Strategies have been implemented within milliseconds for all 30 Arabic native subjects. The results have shown that DMDX is a helpful and a useful technique in Neurolinguistics.

Keywords:

Arabic Language, English Language, DMDX, Semantics, Neurolinguistics.

Introduction:

DMDX, according to Forster, K. I., & Forster, J. C. (2003), is a windows display program with millisecond and accuracy. It is a hybrid name. DM in the name indicates its lineage as part of the DMASTR system. The DX refers to DirectX. When DMDX require something to be displayed, it issues a command to DirectX, not to windows. It is a windows program that accepted the formats of fonts, image files, and sound files which in turn gave the user a wider range of support tool. As per Athaifani (2014a), it is a

bidirectional technique between any two languages either national languages such as Indian languages or international languages as in between Arabic language and English language. Previously, it was used in the domain of Psychology and speech pathology. Recently, this technique has been used to record the reaction time as well as the accuracy in the field of linguistics such as cognitive linguistics, Psycholinguistics and Neurolinguistics. DMDX has many major rules such as compute the syntax data, present them automatically as visual stimuli on the computer screen, and record both the speed and the accuracy of the task.

Semantics is the study of meaning. Priming is an improvement in performance in a perceptual or cognitive task, relative to an appropriate baseline, produced by context or prior experience. As per McNamara, (2005), semantic priming refers to the improvement in the speed or in the accuracy to respond to a stimulus, such as a word or a picture, when it is preceded by a semantically related stimulus (e.g., cat-dog) or when it is preceded by a semantically unrelated stimulus (e.g., table-dog)''. The stimulus to which responses are made (e.g., dog) is the target and the preceding stimulus (e.g., cat or table) is the prime. The classical task for investigating semantic priming is the lexical decision task. The stimuli consist of correctly spelled words and meaningless strings of letters called "non-words" (e.g., blit). On each trial of the experiment, a prime and a target are displayed on a computer screen. Participants are instructed to read the prime silently and then to decide whether the target is a word or a non-word. The standard finding is that lexical decision responses are faster and more accurate when the target is semantically related to the prime (e.g., cat-dog) than when the target is semantically unrelated to the prime (e.g., table-dog).

The brain, perhaps the most precious body part, soft and slightly floppy, somewhat like a pink-gray jello (Parker, 2012). While acquiring a language as example, the people call any one of an empty brain files to accept such new information in. Further, while the population are in need to feed back by any information or anything known and has learnt, they have to go back to the memory and recall all the relevant data that are in need to get and to use them in the correct real feedback and in the exact needful time.

Neurolinguistics (NL) defined as a subset of neuropsychology, namely the study of the representation and processing

of language in the brain. NL is a branch of Cognitive Neuroscience, which, on its turn, together with many other fields such as systemic, movement, sensory, cellular and others, is a branch of a larger domain named the Neurosciences (Ingram, 2007). NL can still be divided into two areas: language acquisition and processing and language impairment (Luria, 1976). The focus on language impairment is a historic one, dating from 400 B.C., with Hippocrates' accounts on infirmities that produced lack of language (Whitaker, 1971, 1976). Contrastingly, the questions about the healthy Faculty of Language – how they come to acquire and use the mother tongue – have been systematically taken for granted through a long stretch of history, despite the fact that language is the one cognition that definitely sets us apart from other animals on this planet. In reality, language investigation has only taken a definite bio-linguistic course in the 1950's with the advent of Noam Chomsky's Generative Grammar (Chomsky, 1957, 1968). And the neurophysiological characterization of the healthy faculty of language, that is, the understanding of language-brain relations at work, only started being investigated specially in the late 1980's, with the introduction of non-invasive cognitive assessment techniques that brought new and exciting perspectives into the field. NL came about as people began to study the effect that damage to the Broca's area of the brain had on language.

In 1980s, the term NL was coined to describe the research. This branch of science directly looks, and the neurons in the brain, and studies how they react to language. Various pathways and damage to certain areas are studied because they pose a direct link to language comprehension and production. NL, as its name implies, is the study of how the brain (''neuro'') permits us to have language ('linguistics'). Neurologists study brain and nerve system. Those neurologists who contribute to the field of neurolinguistics study human neurology and how behaviour breaks down after damage to the brain and nervous system. Linguists study the way human languages is structured. Those linguists who contribute to the field of neurolinguistics are interested in how language structures can be instantiated in the brain (Athaifani, 2014c).

Linguistic Experiment Study

A linguistic study conducted in Dos of Linguistics, Kuvempu Institute of Kannada

Studies (KIKS), University of Mysore. The study was concerned in Linguistic task of Translation Equivalence (TE). 30 Arabic native speakers were participated in this concern. Each and every subject has to complete the task with approximation of 17 minutes. Along with 17 minutes duration, 200 lexical items have been given to the entire subjects in the study experiment.

Methods

Subjects

The subjects were 30 Arabic native speakers, who are aware, conscious, good health, right handed, academic, and high economical group income.

Procedures

- The subjects have been instructed to press only either the button (1) or the button (0) on the keyboard to fulfil this task. The button (1) indicates to TE word, while the button (0) stands for Non-word. The entire subjects have to respond as soon as possible.
- The subjects were seated in a comfortable position facing the 14 inches screen of HP laptop.

The classification of Lexical items in Arabic language

Broadly speaking, in terms of writing, as the opposite way of English language, Arabic language writing system is from right to left. Form the other prespective is that Arabic language comes under Semitic language family. Additionally, the structure of Arabic language is different from that of English language.

Table (1) Components of the task

Non-word	Semantic Un-Related	Transliteration	الكلمة	م
Bisling	Door	Umm	أم	1
Koob /	House	Kitaaab	كتاب	2
Nocea	Table	Qieadh	قيادة	3
Reet	Rice	Kitabh	كتابة	4
Kister	Dad	shaja?h	شجاعة	5
Neplic	Coach	Najah	نجاح	6
Lipcen	Pizza	Istworah	إسطورة	7

Table (1) shown that there are four terms along with 7 lexicons as examples of the study. These 7 lexical items selected from the major study of 200 lexical items. The four linguistic terms are the lexicon, transliteration, SUR and Non-word, respectively. The lexicon, (الكلمة), indicates to the lexicon item (prime word). Transliteration has been given for all non-native speakers to understand the lexicon. SUR is the study terms of Arabic language as SL into English language as TL. Non-word does indicate to the distracters. The standard of distracters has to be 0.3. Non-words were structured based on the phonotactic rules.

The program of DMDX and lexical items

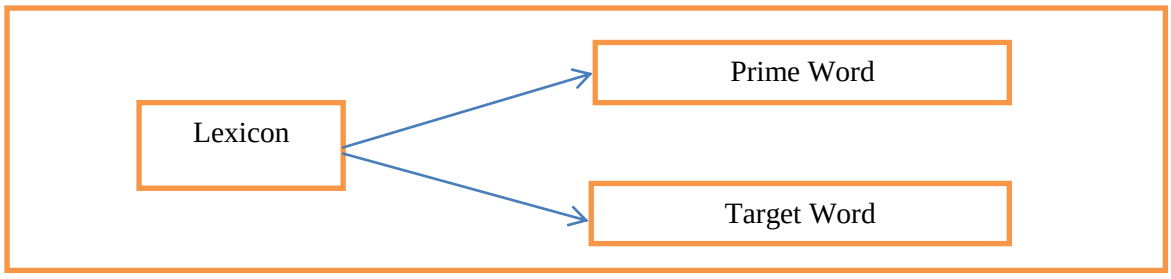
Selection of 200 mentioned lexicons from each language will be the proposal for each and every subject to examine herewith DMDX program. All lexical items have to be computed in DMDX software program. Strategy of the paradigm was computed and selected systematically.

Design and Strategy of the program

The design of the program is that the words have to appear on the screen as the following:

200 lexical units in Arabic language as well as English language have to appear on the screen, each one after another automatically. Therefore, the strategy should be as the following:

Figure (1) Appearance of the lexicon on the screen



It is, then, the prime word, first, has to appear on the screen. Afterwards, a gap has to be given for encoding the item, thinking, calling the semantic shift and long memory and deciding, finally the target word takes the place on the screen. After the time elapsed, the another word will appear on the screen automatically. In this connection, the subject has to go through the entire process and feedback

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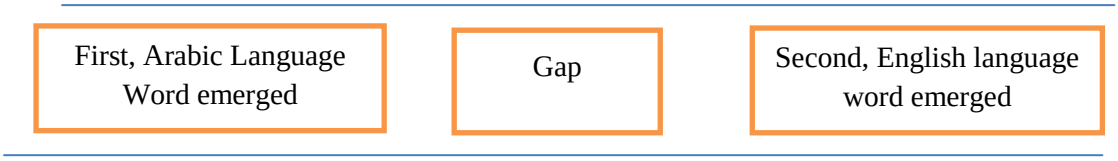
within a given duration of time in milliseconds.

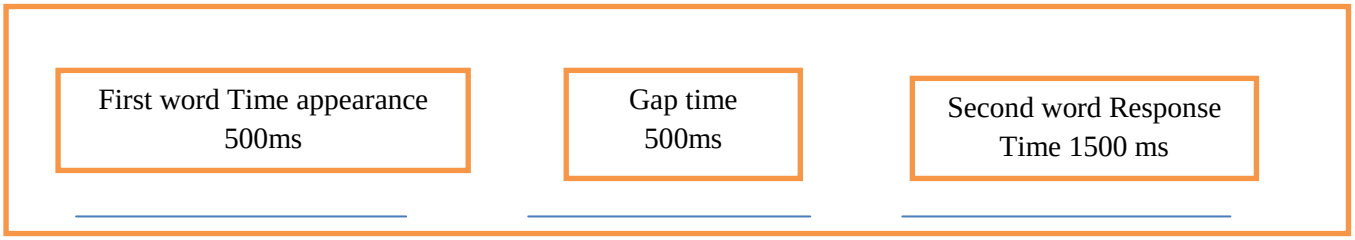
Figure (2) Strategy of the lexicon processing



Short Time Asynchrony (SOA)

Short time asynchrony has been given for each item (appearing time of prime word, gap duration, and target word along with the responding time) as the following:

Figure (3) Distribution processing time



The total time, then, for each and every item is 2500 m sec.(500 msec. + 500 msec.+ 1500msec. = 2500 msec.) , which means that each item is going to take only two and half seconds for the whole process ; on-set and off-set (Appearing of prime word 500 msec., gap 500 msce., appearing the target word and response 1,500 msec.)

Design and strategies of distributing the entire 200 lexical units

Systematically, the distribution of lexical items in the this task was done as the following: there were 200 lexical units, prime and target, so that (144) lexical items will be appeared as TE and (66) lexical items will be appeared as Non-words (NW) ; as the standard of 0.3 of total words should be Non-words. The diagram should be designed, then, as the following:

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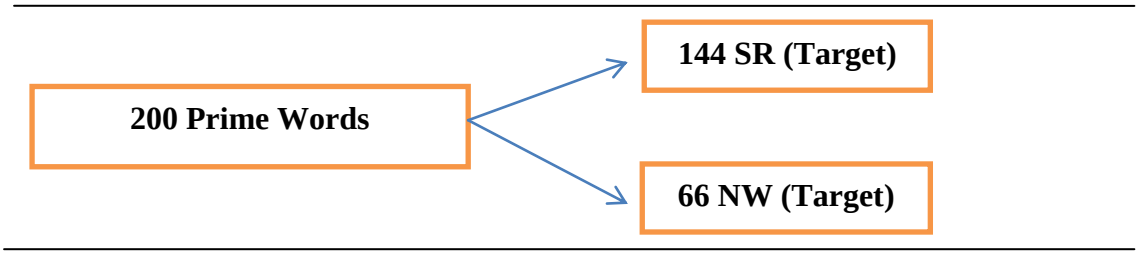
Figure (4) Number of appearing lexical items on the screen



Way of responding

The way of responding would be either by keyboard or by reading the item. If by keyboard, the subject has to press either (1) or (0), if by reading, the subject has to read the lexical item aloud. In this case, the subject required a microphone for doing so. In the current study, the keyboard has been used. The subject, then, has to press the keyboard button/s to respond the emerged stimuli on the screen that have been given in the task. The process has been designed systematically and the stimuli on the screen were also systematically, not randomly presented.

I. DMDX Item File:

Each and every item file has to start with a header line. This sets various parameters for the experiments. An example is shown below:

<azk><cr><fd 42><dwc 0><t 3500><dbc 255255255><id "keyboard" ><df Times New Roman><vm desktop><nfb><dfm 0.5,2.5>

Design and strategies in presenting the stimuli (Words and Non-words)

Examples

0 "Press spacebar to Start" ;

+1 <ms% 500> "**أم**" / <ms% 500>/ <umpr><umnr><mpr +1><mnr +0> * <ln -1> "**door**" <ms% 1500> /;

+2 <ms% 500> "**كتاب**" / <ms% 500>/ <umpr><umnr><mpr +0><mnr +1> * <ln -1> "**koob**" <ms% 1500> /;

+3 <ms% 500> "**شجاعة**" / <ms% 500>/ <umpr><umnr><mpr +1><mnr +0> * <ln -1> "**house**" <ms% 1500> /;

+4 <ms% 500> "**نجاح**" / <ms% 500>/ <umpr><umnr><mpr +1><mnr +0> * <ln -1> "table" <ms% 1500> /;

+5 <ms% 500> "**إسطورة**" / <ms% 500>/ <umpr><umnr><mpr +0><mnr +1> * <ln -1> "**Kister**" <ms% 1500> /;

Semantic Un-Related Task in Arabic Language

Reaction Time

Reaction Time (RT) of Semantic Un-Related (SUR) in Arabic English language was analyzed as follows:

Figure (5) Histogram and frequency curve of RT of SUR in Arabic English Language

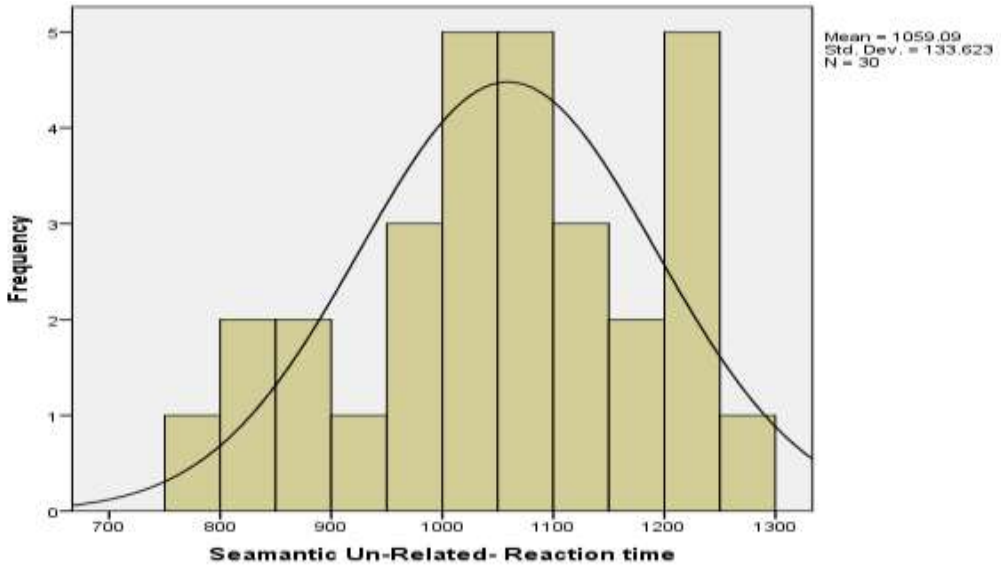


Figure (5) represents the RT of SUR in Arabic English language and seems to be approximately normal with mean of 1059.085 and SD of 133.622.

Figure (5) ,also, has shown that the mean of the entire partricipants ranged in between 700 and 1300 msec. Therefore, it was noticed from the figure that the particapnts have spent most of the time in this task to give their feed back.

Table (2) Test for normality using Kolmogorov Smirnov test.

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Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Seamantic Un-Related- Reaction time is normal with mean 1,059.09 and standard deviation 133.62.	One-Sample Kolmogorov-Smirnov Test	.852	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Due to Figure (5), has shown the normality, it has been applied for KST for the confirmation of the normality. Hence, table (2) has shown that there was no significance because p value was .852, and that does mean there was normal distribution for the entire data of the third task of the study. Therefore, the decision was that H0 has to be remained.

Accuracy

Accuracy of Semantic Un-Realted in the third task of Arabic English was analyzed as follows:

Figure (6) Histogram and frequency curve of accuracy of SUR in Arabic English language.

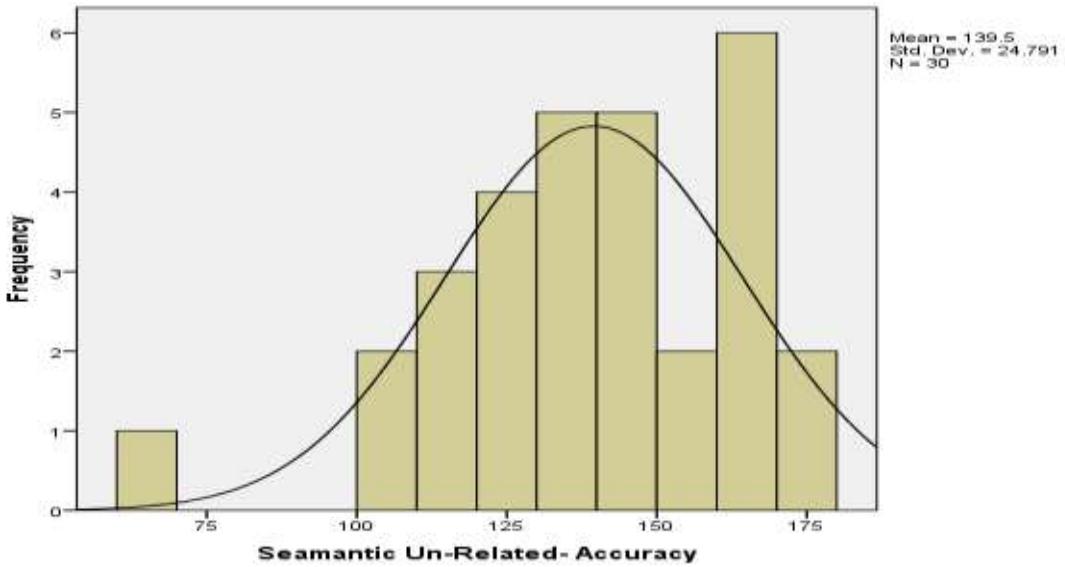

Figure (6) shown that there was approximately normal distribution, the mean of the positive answers for all the participants was 139.5 and SD was 24.791.

Table (3) Test for normality using Kolmogorov Smirnov test.

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Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Seamantic Un-Related- Accuracy is normal with mean 139.50 and standard deviation 24.79.	One-Sample Kolmogorov-Smirnov Test	.894	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

Due to Fig. (6), has shown the normality, it has been applied for KST for data analyses and to confirm the normality. Hence, table (3) has shown that there was no significance and p value is .894, which does mean that there was normal distribution for the entire data of the final task of the study. Thus, H0 has to be retained based on the table results.

t-test:

Data subjected to another test called't-test' in order to compare between them. The results were as follows:

RT and Accuracy in SUR in Arabic language

Table (4) RT and Accuracy in SUR in Arabic language

Test Variables	t-test for Equality of Means			
	T Value	df	Sig. (2-tailed)	Remark
Reaction Time and Accuracy of Semantic Un Related in Arabic language	22.048	58	.000	Sig.

An independent sample t-test was conducted to compare between RT of SUR and accuracy of SUR in English language. Table (4) has shown that there was a high level of significance difference in the RT of SUR in Arabic language (*M= 1059.085, SD of 133.622)* and accuracy of SUR in Arabic language *(M= 139.5, SD 24.791) condition; t (58) =22.048, p=.000.* These results suggest that task that has been submitted for all the participants, for implementation, had many distractions. The common reason is that the linguistic concept non-word. Thus, the significance had occurred between RT interactions. RT, also, does affect on the accuracy for many reasons such as psychological reasons and academic reasons. The psychological reasons were more in regard of RT such as attention, pressure, illness, boring, fatigue etc. It has been shown from the results that the brain reacted for the visual stimuli

within milliseconds as a very fast speed. Moreover, it records the accuracy for the entire subjects as well. It is, therefore, DMDX a very useful technique in NL.

How to obtain DMDX

The complete DMDX package can be downloaded from the homepage for DMDX, which can be accessed by the following links from the DMASTR Web site: (http://www.u.arizona.edu/~forster/dmastr/dmastr/htm). This package includes the program TimeDX, which is an essential partner for DMDX and which must be run to select the desired screen resolution and to time the refresh rate. Also, included are examples of scripts that execute various tasks.

Conclusion:

The study matter concentrated on the major parameter, RT. RT is considered the central concept in SUR. Due to RT, the study focused on cognitive study as the process of thinking considered highly in this regard. Due to RT, also, there were many components including in the study such as coding the lexical units, storing, thinking, (comprehending) retrieving and / or calling the long term memory, and decoding (producing).

The current study has involved in two major factors: 1) the relative time course (RT), and 2) the accuracy. In regard to RT, DMDX strength the study by providing an exact RT for the entire subjects within milliseconds. In regard to accuracy, DMDX enhanced the study by the standard measurement of the performance for the entire individuals, who participated in the present study.

By means of this technique, NL has been significantly improved. Each item is displayed and the item number is then entered for a response. DMDX, then, has been – strongly- exposed that it is a very helpful and a very useful technique in the field of NL either in RT or in the accuracy.

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