Lexical retrieval after Arabic aphasia: syntactic access and predictors of spoken naming

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Research into anomia has been carried out in English and many Indo-European languages extensively, but not in Arabic. Previous studies have investigated predictors of successful lexical retrieval after anomia, and access to syntax during lexical retrieval. The aim of the current study is to examine impaired lexical retrieval in Arabic at two levels: predictors of lexical retrieval, and access to syntax during lexical retrieval, via checking whether syntactic cueing (using the definite article /əl-/ 'the' prior to nouns) facilitates noun retrieval in Arabic aphasia, with regard to naming speed and accuracy, and establishing the determinants of aphasic noun retrieval in Arabic. Three participants with anomia following CVA named 186 pictures from a published Arabic database in two conditions: bare noun condition, and determiner + noun condition. Participants' accuracy and reaction times were compared in both conditions. Furthermore, a multiple regression analysis was carried out to test the effect of psycholinguistic variables (visual complexity, name agreement, age of acquisition, imageability and other intrinsic variables) on successful lexical retrieval to determine predictors of Arabic noun retrieval after anomia. The production of the determiner + noun in picture naming facilitated spoken naming in all three participants. Nouns produced with the determiner were produced faster and more accurately than their counterparts produced without the determiner. The two participants with agrammatism produced morpho-syntactic errors in the bare noun condition, but not in the determiner + noun condition, suggesting that the determiner sets up a noun phrase frame with a slot for the noun to be filled, resulting in responses that are faster and more accurate. Age of acquisition and imageability were the only two variables that had influence across the participants. These results have theoretical and clinical implications for lexical retrieval models.

Keywords: aphasia; anomia; Arabic; lexical retrieval; syntax; word grammar; determiner; noun phrase; spoken production; picture naming; predictors; determinants; psycholinguistics; neurolinguistics

1. Introduction

Anomia is the inability to retrieve words after an injury to the language areas in the brain. It can be caused by a deficit in the mental representation of semantics, syntax or phonology. Additional causes of anomia could be weakening or blocking of the links between representations at different levels (Laine and Martin, 2006). Studies investigating lexical retrieval following anomia have looked into what psycholinguistic factors influence successful lexical retrieval. Studies on anomia have also investigated the effect of semantic and phonological cueing on lexical retrieval facilitation (e.g. Nickels & Best, 1996). More recently, a number of studies have investigated the role of syntax in lexical retrieval through syntactic cueing methods (e.g. Gregory et al., 2010, Herbert and Best, 2010; Ritschel, 2009). This has yielded a vast body of data from Indo-European languages, with clinical and theoretical implications beneficial to speakers of those languages and the overall anomia research body. Previous studies in the current line of research have looked into accuracy of aphasic responses, while reaction times/response latencies have not been used as a measurement of lexical retrieval, based on the assumption that reaction time data may be an unreliable indicator of performance in patients with aphasia due to the heterogeneous nature aphasic reaction times. The current study investigates lexical processing in Arabic, in service of its speakers and the wider body of literature. Moreover, reaction times are used as a measurement of successful lexical retrieval.

1.1 Access to syntax during lexical retrieval

Semantic and phonological cueing methods have been used to facilitate retrieval, and have been shown to improve the lexical retrieval process (e.g. Boyle and Coelho, 1995; Howard, Patterson, Franklin, Orchard-Lisle, & Morton, 1985; Law, Wong, Sung and Hon, 2006). Furthermore, activation of semantics and phonology during lexical retrieval has been found to be robust and non-arguable (Caramazza, 1997; Dell, Schwartz, Martin, Saffran, & Gagnon, 1997; Levelt, Roelofs, & Meyer, 1999; Paterson and Shewell, 1987). Activation of syntax during lexical retrieval has been a matter of dispute among scholars. While Dell et al. (1997) and Levelt et al. (1999) maintain that syntax is central to lexical retrieval, Caramazza, (1997) questions whether access to syntax during lexical retrieval is needed.

According to Levelt et al.'s (1999) Weaver ++ model, lexical retrieval starts with the conceptual preparation stage which is followed by the lexical selection (lemma). After the lexical selection stage, morphological and phonological encoding takes place and finally phonetic encoding and articulation occurs. Levelt et al. (1999) maintain that during the lexical selection stage activation is spread to the target word's lemma node, at which the syntax of the target word becomes available for grammatical encoding, by creating the suitable syntactic environment for the target word. Information such as number and gender for nouns, and argument structure, tense, mood, person and number for verbs are encoded at this level, allowing speakers to combine words to form sentences (e.g. Cleland and Pickering, 2003). The Weaver++ model is based on the assumption that these levels of processing are independent from each other, activation is feed-forward; once a lexical node is selected at a certain level, it has no influence on previous levels.

Dell et al.'s (1997) Interactive 2-step model proposes three layers of processing; semantic, word (lemma), and phoneme (phonology). The 'word layer' at which syntactic information of the target word is retrieved. This level is responsible for grammatical encoding which in turn determines the most appropriate syntactic environment for the word in question (Dell et al., 1997). According to Dell et al. (1997), after semantic nodes for a given noun are activated, the activation spreads to the word or syntactic level which mediates between semantics and phonology. This activates all possible syntactic environments that are relevant to the target noun. The 2-step Interactive model suggests that while levels of processing are represented independently, they influence each other and overlap in time. Once lexical nodes are selected, they send activation back to nodes at preceding levels. Then, they spread activation forward to nodes at the next levels.

In contrast with the models presented above, Caramazza's (1997) Independent Network (IN) model proposes a dual-stage model in which an activation of semantic features is followed by parallel and independent activation of syntactic features and phonological form, suggesting that access to syntax and phonology occur independently and in parallel in single word production. Caramazza (1997) questions whether the lemma level is necessary in lexical retrieval, citing evidence from brain-damaged patients with selective grammatical class impairments restricted to either oral or written production, including a disadvantage in verb production either orally or in writing but not in both. This dissociation argues against an amodal lemma level. The Independent Network is a forward activation model, like the Weaver++. However, Caramazza (1997) maintains that the activation from lexical-semantic representations to lexical-syntactic representations and the word-form networks spreads simultaneously and independently, which is unlike the Weaver++ and the 2-step Interactive models.

1.2 Neuropsychological and experimental evidence

Investigations of both views have been undertaken in healthy participants (e.g. Miozzo and Caramazza, 1997; Vigliocco et al., 1997) and participants with aphasia (e.g. Herbert and Best, 2010; Friedmann and Biran, 2003). Findings from these studies varied depending on the methodologies used and different populations of participants. Some studies were in support of the view that access to the lemma is necessary during lexical retrieval, while others maintained it is optional.

Miozzo and Caramazza (1997) asked their healthy Italian-speaking participants to recognize the initial phoneme, grammatical gender and the final phoneme of unavailable words during tip-of-the-tongue state. The results showed higher accuracy in grammatical gender recognition than phonemic recognition of target words. This led the authors to suggest that there is no correlation between syntactic and phonological information, which is incompatible with the Weaver ++ and the Interactive 2-step models.

Recent evidence from Herbert, Anderson, Best and Gregory (2014) was in support of Caramazza's (1997) IN model. The authors investigated syntactic processing in fourteen healthy controls and thirteen speakers with aphasia through naming mass and count nouns, and completing a noun syntax judgment task. The results suggest a lack of relationship between naming accuracy and syntax as evident from the error analysis. Participants' semantic errors were best explained within the IN model (Caramazza, 1997) where there is damage to phonological access, suggesting that there was partially phonological information available in the absence of syntactic information; syntax could be available but activation of syntax is not obligatory. Herbert et al. (2014) conclude that the activation of syntax could operate flexibly dependent on task demands.

This conclusion is consistent with Vigliocco et al.'s (2011) review of noun and verb processing studies. Vigliocco et al. (2011) concluded that activation of a syntactic level during lexical retrieval was not supported by enough evidence across methodologies: behavioural, electrophysiological, neuropsychological and neuro-imaging. They further conclude that studies reporting findings of activated syntax during lexical retrieval have incorporated an explicit request to activate it in the experimental design, such as explicitly asking about number, case and gender.

Friedmann and Biran (2003) investigate access to grammatical gender during picture naming through analysing 532 paraphasias produced by 22 Hebrew speakers with anomia. None of their participants showed gender preservation during naming, regardless of their type of anomia. They concluded that gender is not accessed in bare noun production in Hebrew (a language that allows bare nouns), suggesting that gender and other syntactic features of words are only accessed when produced as a full noun phrase (e.g. with a modifier or a determiner) that is incorporated in a wider syntactic frame, where agreement within the different parts of the phrase is required.

In response to the view that access to syntax can only occur when words are incorporated in a syntactic frame in which agreement is required, recent studies have made use of determiners which do not inflect for any morpho-syntactic features, such as gender and number, among other determiners (e.g. English: Gregory, Herbert, & Varley, 2010, Herbert and Best, 2010; Herbert, Webster and Dyson 2012; Maltese: Ritschel, 2009), accounting for the criticism of requesting syntactic information explicitly may have confounded effects reported in previous studies. These studies have investigated syntactic cueing effects on lexical retrieval in speakers with anomia.

In an anomia therapy study, Gregory et al. (2010) investigated the effect of syntactic cueing on lexical retrieval with KW who is a participant with anomia as a result of a deficit in mapping from semantics to phonology. The authors assessed KW's naming in four cueing conditions: determiner (e.g. some/a/an____), clause (e.g. this is ____), clause + determiner (e.g. this is some/a/an____) and noise (control). They found that all three syntactic cue conditions resulted in higher naming accuracy compared to the control condition. The clause + determiner condition made the highest contribution to successful naming. Furthermore, this condition was used in a three-week therapy procedure. Gregory et al. (2010) reported that therapy using syntactic cues had a significant positive effect on KW's lexical retrieval.

Herbert and Best (2010) reported the case of MH who had anomia as a result of a deficit in mapping from intact semantics to phonological form. MH had an impairment in accessing determiners and/or noun phrase structure. Herbert and Best (2010) investigated MH's production of count versus mass nouns and found that she had an advantage for count nouns. They proposed that "noun production is facilitated by determiner or noun phrase structure access" (p.338). On the basis of this assumption, if damage to syntax in MH's case had resulted in compromised access to specific types of determiners and the noun phrases that they combine in, then providing MH with the determiner only should contribute to her retrieval of the target noun. The authors carried out their experiment with MH under this assumption, and found that the use of determiners as syntactic cues increased MH's ability to retrieve mass noun phrases. They concluded that providing determiners as syntactic cues prior to noun production had activated syntactic nodes at the lemma level. This conclusion is in line with the proposal that syntactic nodes can be activated even when bare nouns are retrieved. It is consistent with results from Cubelli, Lotto, Paolieri, Girelli and Job (2005) and, Kulke and Blanken (2001) but contrasts with claims that syntactic nodes are not activated in bare noun production (e.g. Caramazza, 1997; Friedmann and Biran, 2003).

In an anomia therapy study, Herbert, Webster and Dyson (2012) developed an intervention for six patients with aphasia using nouns in syntactic contexts, and presenting determiners as syntactic cues. The authors assumed that the presentation of the determiner would improve the production of treated nouns. They report an improvement in five out of six patients in the treated words, but this did not uphold for the untreated items. They further report that four of their patients had an increased number of determiner plus nouns in their connected speech. The authors interpret their results within the Weaver++ (Levelt et al., 1999) and Interactive 2-stage (Dell et al., 1997) models, supporting an amodal syntactic level of processing, i.e. lemma.

Evidence from Maltese was also present in Ritschel (2009) who conducted a study on the effect of phonological, syntactic and phonological-syntactic cues on word production in Maltese aphasia. Ritschel (2009) reported that syntactic cueing using the Maltese definite article /il-/ facilitated noun production in Maltese aphasia. However, it did not have as strong an effect on accuracy and reaction time as phonemic cueing. Ritschel (2009) explained the effect of syntactic cueing on word production as a result of boosting activation from and to lemma nodes, which is compatible with Dell et al's (1997) Interactive 2-step model, which permits activation to spread in feed-forward and feed-back mechanisms.

Fieder and colleagues (Fieder, Nickels, Biedermann, and Best, 2014; Fieder, Nickels, Biedermann and Best, 2015) looked into the lexical-syntax representation of number in a group number of patients with aphasia. In two different studies, Fieder et al. (2014) and Fieder et al. (2015) report the cases of RAP and DEH, respectively. RAP had countability specific deficit of mass noun grammar. DEH had impaired lexical-syntax resulting from an impairment in the route from lexical-syntax to the phonological output lexicon. Both participants showed grammatical difficulties in mass noun processing, but a less impaired processing of count nouns. Their mass nouns deficit resulted in the production of determiners specific to count nouns (e.g. 'a' and 'many') with mass nouns, resulting in grammatically incorrect noun phrases e.g. 'a rice'. The accuracy of both patients' increased when the number of objects of the target noun matched the number information in the target determiner. For example, the determiner 'some', containing 'MULTIPLE' in its meaning, was produced correctly when the target mass noun was presented to the patients as multiple objects (e.g. three apples, instead of one apple). Fieder and colleagues (2014 and 2015) concluded that due to the patients' lexical-syntactic impairment, the target mass noun determiners could not receive sufficient activation from the mass noun representation at lemma level. This resulted in using the semantic information (number in this case) to select the appropriate lemma node, suggesting that lexical-syntactic mass and count information is pivotal for the selection of mass determiner, and that semantic number information has an impact on the processing of lexical-syntactic mass and count nouns.

1.3 Predictors of successful lexical retrieval after anomia

A number of factors have been found to influence lexical retrieval in speakers with aphasia (e.g. Nickels and Howard, 1995; Gardner, 1973; Rodriguez-Ferreiro et al., 2009). These factors are properties of the stimuli and contribute to the speed and accuracy of lexical retrieval. Variables influencing lexical retrieval in aphasia include frequency, familiarity, age of acquisition, imageability/concreteness, operativity, animacy and word length (see Nickels, 1997 and Laine and Martin 2006, for a review), depending on the type of anomia presented; different types of anomia yielded different effects (Laine and Martin, 2006). The effect of such factors has been investigated in people with brain damage in various Indo-European languages (e.g. Nickels and Howard, 1995; Gardner, 1973; Rodriguez-Ferreiro et al., 2009), but not for Arabic. Arabic words are morphosyntactically complex and have a number of underlying morpho-syntactic features that have not been investigated in previous studies on determinants of lexical retrieval.

1.2.1 Variables specific to Arabic

Besides variables investigated in other languages, this study addresses variables specific to Arabic, which are rationality and the plural system in Arabic. Rationality in Arabic linguistics is a semantic concept that classifies nouns into two categories: rational and irrational nouns. This semantic phenomenon exists in other languages, such as Tamil but does not exist in English. Rational nouns are those which refer to human beings and deities. They are also called intelligent nouns. In addition to human beings, nouns referring to angels and the devil are included in this class. Some examples of rational nouns are /dəktu:r/ 'doctor' and /wələd/ 'boy'. Irrational nouns are those which refer to non-human beings and non-deities. They are also called non-intelligent nouns. Irrational nouns refer to non-living objects and concepts (abstract nouns) and living non-human beings, like animals and plants. Some examples of irrational nouns are /kəlb/ 'dog' and /kɪtæb/ 'book'.

Arabic has two plural types. Dual plurals refer to two items only. Plurals that refer to three or more items are divided into sound and broken plurals. Dual and sound plurals are formed through gender-inflected suffixation of the singular form of a given noun, and are deemed the regular form. Broken plurals are formed through changing the vocalic pattern of the noun, and are deemed the irregular form. Both rationality and plural type of nouns in question have been investigated in this study to explore whether underlying morpho-syntacic features can predict successful lexical retrieval in Arabic.

1.3 The aim of the current study

Studies of the determinants of spoken word production and the role of syntax in lexical retrieval have been abundant for Indo-European languages, but have not been available for Arabic. Arabic is the largest living member of the Semitic languages. It ranks fifth among world languages in its number of speakers after Chinese (Mandarin), English, Hindi and Spanish. It is the standard language spoken in 23 countries. Arabic is also understood and read by the majority of Muslim people (Lewis, 2009). Spoken Arabic is the colloquial form of Arabic that has many variations depending on the region and country. It has been classified by Arabic sociolinguists into four major groups: North African, Egyptian, Levantine and Gulfian (Zughoul, 2007). Each group may contain two or more spoken sub-dialects. Jordanian spoken Arabic is the variety under investigation in this research project. This is a sub-variety of Levantine Arabic which includes Lebanese, Syrian, Palestinian and Jordanian. These varieties share common features; they overlap and tend to shade into one another in terms of lexical, morphological and syntactic features, but differ in the pronunciation of consonantal phonemes and vowel quality (Cleveland, 1963).

The aim of this study is to investigate lexical retrieval (spoken word production) following aphasia in Jordanian Arabic at two levels. The first is to investigate the impact on naming speed accuracy and error patterns of producing the nouns in a bare noun condition versus determiner + noun condition. The second aim is to investigate the effects of specific variables including name agreement, visual complexity, age of acquisition, imageability, number of phonemes, normative reaction time, plural type, and rationality on spoken naming in Jordanian Arabic speakers with aphasia.

To the best of the authors' knowledge, psycholinguistic predictors of impaired lexical retrieval following Arabic aphasia, and the role of syntax in lexical access in Arabic have not been investigated, to date.

2 Methods

2.1 Participants

Three people with aphasia took part in this study (P1, P2, & P3). All three cases and their neuropsychological profiles were presented in detail in Khwaileh, Body and Herbert (2015). They were all literate native speakers of Jordanian Arabic, right-handed, above the age of 18 years old, and were recruited from two hospitals in Jordan. All participants went through Arabic schooling system. Prior to their injuries, they had normal speech and language development and no history of other significant neurological or any psychiatric disorders. They had a single left cerebrovascular accident (CVA) which resulted in aphasia, in absence of dysarthria, apraxia of speech and homonymous hemianopia. All three participants presented with anomia, and were not undergoing any therapeutic procedure at the time of study. Participants' speech and language therapists and neurologists provided background information including initial diagnosis and medical history. Ethical approval for the study was obtained from the hospitals' ethics committee and The University of Sheffield. Informed consent to participate was obtained.

To establish the neuropsychological profile for each participant's aphasia and identify the functional loci of their anomia, we used translated and culturally modified unpublished subtests of the Comprehensive Aphasia Test (CAT) (Swinburn, Porter & Howard, 2004) and unpublished subtests that have been developed by speech and language clinicians in Jordan (Zaidan Khamaiseh, Personal Communication). A list of those subtests appear in the table below. The selection of these tests was constrained by the materials available for assessment in Jordanian Arabic in clinics in Jordan at the time of assessment. Furthermore, a connected speech sample was recorded from each participant, to measure fluency, spoken word production and grammatical construction in connected speech in line with Herbert, Best, Hickin, Howard and Osborne (2008). The assessment results are presented in tables 1 and 2.

Tables 1 and 2 about here.

P1 was a 22 year old female who was a final-year undergraduate student prior to her CVA. Prior to her injury, she spoke English fluently besides her native language i.e. Arabic. She was 12 months post-onset when she participated in this study. Her CVA was a result of a complication of surgery for resection of a carotid body tumour. Her CT scan showed a large area of low attenuation involving left anterior and middle cerebral artery territories. Her CVA resulted in encephalomalacia involving the above arterial distributions and deemed not degenerative, as reported by her neurologist. P1's aphasia can be classified as Broca's aphasia as she presented with anomia, non-fluent production, intact lexical auditory comprehension, and compromised repetition (Basso, 2003). Her expressive language in the conversation sample shows that she presented with agrammatic production with difficulty in formulating grammatical constructions. She could correctly produce some single words and phrases. Phrases were not grammatical lacking number and gender agreement. Her language did not include subject-verb-object sentences and complex sentences. She also presented with agrammatism in comprehension, as revealed by her performance in sentence comprehension tasks. P1's performance on lexical processing tasks (table 1) indicates that the source of her word finding difficulties lies in access to the phonological output lexicon from the semantic system, and impaired phonological assembly.

P2 was a 24 year old female who suffered a single CVA nine months before her participation. Prior to her injury she had completed an undergraduate degree, and worked as a teacher. She is a native speaker of Arabic and did not speak any other language. Her CVA was a result of an arteriovenous malformation (AVM) on the middle cerebral artery (MCA) causing a left sylvian haematoma. Her CT scan showed a fronto-parietal acute haemorrhage in the area mainly supplied by the MCA. P2's aphasia can be classified as transcortical motor aphasia, as she presented with anomia, non-fluent production, intact lexical auditory comprehension, and preserved repetition (Basso, 2003). Agrammatism was present in P2's production in conversation. The majority of her utterances were simplified grammatical structures with single and two-word phrases forming the majority. The most complex syntactic structures she produced were subject-verb-object sentences some of which were grammatical. Spoken and written sentence comprehension was better preserved. Assessment of word finding indicates that her anomia arises at access to the phonological output lexicon from the semantic system, and in phonological assembly.

P3 was 62 year old male who suffered a single cerebrovascular accident (CVA) in the left cerebral hemisphere twelve months before his involvement in this study. P3 had been formally educated up to secondary school and left when he was 17 years old. He is a monolingual speaker of Arabic. His CT shows a hypo-dense lesion in the left parietal region representing an ischaemic infarct. Prior to his CVA P3 had a history of hypertension, diabetes mellitus and ischemic heart disease which are believed to have predisposed him to CVA. P3's aphasia has been classified as transcortical motor aphasia. His expressive language was non-fluent and effortful. He produced single words, two-word phrases and some grammatically correct sentences. His most complex grammatical structures were subject-verb-object sentences and sentences with prepositional phrases as compliments for verb phrases. Word finding difficulties were present through his conversation. Sentence comprehension tasks revealed that agrammatism was present in comprehension. His assessment of lexical processing indicates that his anomia was a result of impaired phonological assembly and possible damage to accessing phonological output lexicon from semantics.

2.2 Design

The experiment consisted of a naming task conducted in two conditions. The first condition was bare noun production. The second condition involved naming the same 186 pictures with a determiner + noun phrase. Reaction time and accuracy were measured on both occasions. All target noun pictures represented singular form and were to be produced with a definite article /əl-/ preceding the target noun. While Arabic has many determiners, the Arabic definite article was chosen due to the fact that it does not inflect for any grammatical information. It is a neutral determiner that can precede any noun regardless of number, gender or case. This would challenge the assumption that determiners can only facilitate lexical retrieval if they inflect for syntactic properties of the noun they determine (e.g. Miozzo and Caramazza, 1999; Schriefers, 1993; Schriefers, Jescheniak and Hantsch, 2002).

Each of the first and the second condition sets were split into two further subsets. There were 186 items in the experiment, each presented twice. The design was an ABBA design, wherein half of the items were presented first in bare noun condition and half were presented first in the determiner condition. The experiment was conducted over four sessions in each of which half the stimuli were presented in either bare noun or determiner condition. The time gap between each session was two weeks.

The presentation order of the stimuli was randomized using the randomizing function on the Excel Microsoft Office. Then within each list of 93 targets, items were checked to ensure that at least three items intervened between semantically related items and between phonologically related items.

2.3 Materials

All 186 nouns and their pictorial representations from the Levantine Arabic normative database (Khwaileh, Body & Herbert, 2014) were used in this experiments. All pictures represent singular concepts and had 96% and above name agreement.

The Response Recorder software (Mike Coleman, unpublished) was used to present the pictures in both conditions. It recorded reaction times, and stored each audio response in sound files. It displayed an initial blank screen for 1000ms, followed by a central fixation cross (+) serving as prompt to look at the centre of the screen, which remained on the screen for 1500ms. The picture then appeared on the screen and remained until the participant attempted to name the picture. If the participant failed to respond within 20,000ms, a blank screen appeared in preparation for the next picture. If a participant named the picture, the researcher pressed the time button at the onset of the participant's speech then pressed another button to move to the next picture. For both conditions, pictures were configured to 885 pixels width by 600 pixels height for presentation on a laptop screen with a screen resolution of 1024 by 768 pixels.

A headset microphone was adjusted at approximately 5cm from the participant's mouth to record their speech. In addition, the whole task was recorded using an Olympus recorder to enable revisiting the stimuli in case the sound file failed to save and to check for false triggering.

The Response Recorder recorded reaction times for all spoken responses on both conditions. The reaction time measured the gap between the appearance of the image on the screen and the onset of the participant's spoken response.

2.4 Procedure and administration

Participants were assessed individually in quiet speech and language therapy clinic rooms. The experiment involved 4 sessions of 1 session a week with one week between each session over a period of 7 weeks. Prior to commencing naming, participants were informed about the procedure. All instructions were presented in spoken and written Arabic. They were asked to produce each noun with the definite article. The researcher did 5 items in front of the participant. Participants were then presented with practice items in order to ensure that they understood what was required of them. If a participant did not understand what was required, further instructions and practice items were given. Participants were informed that they could ask for a break or end their participation at any time. The first author administered all assessments.

2.5 Response coding and reaction time measurement

All spoken responses were transcribed in situ by the first author, and later checked from the audio recording. Responses from both conditions were coded using the coding system in Appendix A. Responses from the determiner + noun condition were first coded for the presence of the determiner in noun production. The data were coded twice to check intra-rater and interrater reliability. The transcribed and coded data were then recoded by the researcher 3 months later at the time of analysis, disagreements were discussed with the SLT in Jordan and co-authors in search for the best code for a given response.

The cut off time for naming was set at 10000ms, and the first response only was coded. Reaction times generated by the naming software were then copied into PRAAT Software (Boersma and Weenink, 2009; version 5.1.17) for both conditions. The reaction times for nouns in condition 1 (bare noun) were manually recalculated from the moment the stimulus appeared from the screen to the beginning of the initial phoneme of the target noun. The reaction times for the second condition (determiner + noun) were determined by measuring the time from presenting the stimulus to the onset of the initial sound in the noun after the definite article 'al', rather than to the onset of the definite article itself. False triggering in both conditions and items produced with the article + pause + target noun were re-measured using PRAAT software (Boersma and Weenink, 2009; version 5.1.17). The onset of naming for each item was recalculated. The resulting reaction times were checked for outliers, then the 5% trimmed means procedure was performed. This procedure replaced extreme outliers (above 2 standard deviation from the mean) with values of the mean plus two standard deviations. This was carried out in preparation of the data for parametric statistics i.e. multiple regression.

3 Results

3.1 Comparison of naming accuracy across conditions

The aim of the accuracy analysis was to compare the number of accurate responses in the two conditions. Accuracy of single noun production in the bare noun condition with accurate determiner plus noun in the determiner + noun condition were compared.

Only items produced with a determiner in the second condition were included in this analysis. Items excluded were those produced with no determiner (nouns in isolation) in the determiner + noun condition. Out of the 186 items included in this condition, P1 produced 180 items with the target determiner, P2 produced 175 items, and P3 produced 170 items.

The accuracy of responses in both conditions was compared. Accurate responses included accurately produced nouns in the bare noun condition and accurately produced nouns preceded by a determiner in the determiner + noun condition. Table 3 presents accurate responses across all participants.

Table 3 about here.

There were significant differences in participants' accuracy between the two conditions. All participants produced more accurate responses on the determiner + noun condition (McNemar test: P1: $p<.05$, P2: $p<.05$ and P3: $p<.05$). The production of the determiner prior to the noun made a significant positive contribution to the accuracy of the retrieved noun, implying that spoken naming was facilitated by producing the noun within a determiner + noun syntactic frame.

3.2 Comparison of reaction times across conditions

Only items named correctly in the bare noun condition and those named correctly with a determiner preceding determiner in the determiner + noun condition were included in this analysis. Items that were produced with the article + pause + target noun were also excluded. These criteria reduced the number of items included in this analysis per participant (P1: 71; P2: 105; P3: 106). Reaction times were checked for accuracy of measurement through PRAAT. The onset was measured as the first consonant of the target noun. In nouns starting with a sun phoneme, the onset was set at the middle of the geminate noun resulting from the assimilation of the /l/ in the definite article and initial sun phoneme of the target noun.

None of the data sets were normally distributed. Trimmed reaction times entered the analysis. The reaction times were compared within each participant across the two conditions.

Figure 1 about here.

Analysis revealed that the production of the determiner prior to the noun resulted in a shorter reaction time for the retrieval of the noun. The difference between reaction times on the two conditions was significant for P1 ($z = -8.375$, $p<.0005$), P2 (Wilcoxin Signed Rank test: $z = -2.772$, $p<.001$) and P3 ($z = -2.934$, $p<.005$).

3.3 Error analysis

All errors were coded for response types. Table 4 presents proportions of response categories from both conditions.

Table 4 about here

Accuracy results show a statistically significant difference in error types between the two conditions. In the determiner + noun condition, there was a decrease in semantic and phonological errors for all three participants (McNemar P=.000), a decrease in morpho-syntactic errors in P1 and P2's data (McNemar, P=.000), and a decrease in 'no response' category for P2 (McNemar, P=.000). The reduction of visual and other errors was statistically insignificant for all three participants.

On the determiner + noun condition, none of the participants produced morpho-syntactic errors in items produced with a determiner. Conversely, participants P1 and P2 produced morpho-syntactic errors in the bare noun condition. P2's morpho-syntactic errors included nine gender errors in which she produced the masculine inflection instead of the feminine (e.g. /mʊʕəlımə/ 'female-teacher' became /mʊʕəlım/ 'male-teacher'). All her gender errors were a result of omission of the feminine suffix. There were also five number errors in which she substituted number inflection (e.g. /təjərə/ 'plane' became /təjəræt/ 'planes') by making omission and addition errors. All her number inflection errors resulted in a plural form of the target word. P1's morpho-syntactic errors contained 17 inflectional errors where feminine gender suffix was omitted (e.g. /mʊɣənjə/ 'female singer' became /mʊɣəni/ 'male-singer') and two derivational errors in which an adjective was produced instead of the target noun (e.g. /bʊrtʊgələ/ 'orange' became /bʊrtʊgəli/ 'orange [the colour]').

Overall, all three participants showed a significant effect of determiner production on accuracy and reaction time of spoken naming. Naming was more accurate and faster in the determiner + noun condition compared to the bare noun condition. Furthermore, the production of the determiner had an effect on error types. Morpho-syntactic and visual errors were absent in the items produced with a determiner, but present in the first condition.

3.4 Lexical retrieval predictors

3.4.1 Predictors of accuracy

Correlational analysis was carried out to explore the relationships between the psycholinguistic variables and accuracy (table 5), in the first condition.

Table 5 about here

Rationality and accuracy had a negative correlation in which irrational nouns were more accurate than rational nouns in P1's data. She also showed a significant negative correlation between age of acquisition and accuracy indicating that words learned at an early age were more accurate than ones learned later in life. Imageability and accuracy had a positive correlation which indicates that P1 found items with high imageability easier to name than low imageability items. P2 was significantly more accurate in naming pictures with low visual complexity, than she was in more complex pictures. Imageability showed a positive correlation with accuracy. There was a negative correlation for normative reaction time. P3's accuracy had positive correlations with name agreement and imageability. Age of acquisition and normative reaction time had negative correlations with his accuracy.

The regression analysis included only those variables that significantly correlated with accuracy. Logistic regression was applied to the data in order to identify the degree to which relevant variables significantly predict the accuracy of spoken naming for each participant. All three regression models were statistically significant; P2 (χ^2 (3) = 20.680; $p<.05$), P1 (χ^2 (3) = 27.391; $p<.05$) and P3 (χ^2 (5) = 29.172; $p<.05$). P2's model explained 11% to 14% of the variability of the dependent variable i.e. accuracy. P1's model explained 14% to 19% of the accuracy variability, and P3's model explained 15% to 21% of the accuracy variability. P2's model correctly classified 62.4% of the overall cases, P1's 65% and P3's 73.1%. The results from the logistic regression analysis are presented in table 6.

Table 6 about here

Imageability was found to make the strongest contribution to the prediction of accuracy in P1's picture naming. Rationality was the second strongest predictor of accuracy. Finally, age of acquisition was the third strongest predictor of accuracy. The forward-Wald logistic regression procedure revealed that each of these variables was still a significant predictor of accuracy after controlling for other variables: imageability (Wald (1) = 4.536, $p<.05$), rationality (Wald (1) = 3.853, $p<.05$) and age of acquisition (Wald (1) = 4.788, $p<.05$).

Rationality effect on spoken naming has not been examined before in the literature. Therefore, it was important to check if the rationality effect found on P1's accuracy was a true one or an effect of another underlying factor. A possible variable underlying rationality may be animacy. Rationality and animacy were significantly correlated (r = .493, n = 186, p<.05) according to Khwaileh et al. (2014). This relationship is attributed to the fact all rational nouns are animates, and irrational nouns can be animate and inanimate. This suggests that the rationality effect could be an animacy effect. Therefore a post-hoc analysis on P1's data was conducted to check whether animacy influences her accuracy. The forward-Wald logistic regression was conducted to check if animacy influenced P1's accuracy, and whether the influence of rationality on accuracy is an underlying effect of animacy. The regression revealed that animacy did not significantly predict P1's accuracy (Wald (1) = 0.839, p>.05). This suggests that rationality had an independent effect on P1's naming accuracy.

The only predictor that significantly contributed to P2's lexical accuracy was imageability. The direction of the prediction was positive. A forward-Wald logistic regression was carried out to check if imageability still significantly predicted accuracy after controlling for visual complexity and normative reaction time. This procedure revealed that imageability was still a significant predictor of accuracy even after controlling for other predictors (Wald (1) = 10.096, p<.05). For P3, name agreement was the strongest predictor of accuracy. The direction of the prediction was positive. Age of acquisition was the second significant predictor of P3's accuracy of spoken naming. The direction of the β-value was negative. The forward-Wald logistic regression revealed that name agreement (Wald (1) = 3.737, p<.05) and age of acquisition (Wald (1) = 7.671, p<.05) were still significant predictors of accuracy after controlling for all other independent variables.

3.4.2 Predictors of reaction time

This subsection presents analysis of reaction time data to establish which of the psycholinguistic variables influenced the reaction time of spoken naming. The independent variables were the same ones used in the accuracy analysis described above. The dependent variable was reaction time in naming in place of accuracy. Only reaction times of accurate responses taken from condition 1 (bare noun naming) were included (P1: 80 items, P2: 107 items, & P3: 128 items). Reaction time data were prepared for analysis, and then correlational analysis and simple regression procedure were carried out. The reaction time data were prepared prior to analysis because it is more sensitive potentially and has gradation of responses unlike the accuracy data which is binominal.

Normality was checked for the distribution of trimmed reaction time values via the one-sample Kolmogorov-Smirnov normality test which showed that none of the participants' data were normally distributed: P1 (D(80) = 0.123, p<.01) P2 (D(107) = 0.216, p<.01), and P3 (D(128) = 0.237, p<.01). Data from all participants were substantially skewed. The trimmed reaction time values were therefore transformed to get a symmetric distribution (resembling normal distribution) before applying any further parametric analysis, by reducing the skewness. Choosing the type of transformation was motivated by the shape of the data from each participant. Both P2 and P3's data showed left-skewness which requires an Inverse transformation to reduce the left-skewness. On the contrary, P1's data showed a right-skewness which requires a square-root transformation to reduce the right-skewness. The inverse transformation procedure was carried out for P2 and P3's data. For P1, the square root transformation procedure was applied. The transformation of the data and trimmed means procedure have been carried out to fulfil the normality assumptions and requirements of parametric statistical analysis i.e. multiple regression analysis. Transformed data were normally distributed for P1 (D (80) = 0.113, p>.01); P2 (D (107) = 0.069, p>.01), and P3 (D (128) = 0.081, p>.01). The transformed data were further analysed to explore the influence of the independent variables on reaction time. Correlational analysis was conducted to explore the relationships between the independent variables and reaction time values for each participant.

Table 7 about here.

The correlational analysis of reaction time data showed less significant relationships than accuracy data. Table 7 indicates that only normative reaction time significantly correlated with P2's reaction times. None of the variables in question significantly correlated with reaction time for P1. Age of acquisition was the only variable that significantly correlated with reaction times yielded by P3.

Predictive power of normative reaction time for P2, and age of acquisition for P3 were further examined through the simple regression analysis which was applied to P2 and P3's data only. P1 was excluded from this analysis because none of the independent variables significantly correlated with reaction time. For participants P2 and P3, the dependent variable was the transformed reaction time of accurate items only. The independent variables were only variables with significant correlations with reaction time. P2's model explained 14% (R^2 = .138) of the reaction time variance. The regression was significantly different from zero (F (1, 96) = 2.92, p<.05). P3's model explained 8% (R^2 = .08) of the reaction time variance. The regression was significantly different from zero (F (1, 126) = 8.75, p<.05). Simple regression analysis revealed that normative reaction time was a significant predictor of P2's reaction time (t (107) = 2.819, p<.05). The direction of this prediction was positive (standardised Beta-β = .323) indicating that P2 was slower in naming items with long normative reaction time. Simple regression analysis revealed that age of acquisition was a significant predictor of P3's reaction time (t (128) = 1.434, p<.05). The direction of the prediction was positive (standardised Beta-β = .104).

4. Discussion

In this study we examined the effect of determiner production on aphasic reaction time and accuracy of noun retrieval. The production of the determiner prior to the noun in picture naming facilitated spoken naming in all participants. The study also found that age of acquisition and imageability were the only two variables that had influence across the participants. Rationality, a variable that has not been investigated before, has been found to be a significant predictor of P1's accuracy during lexical retrieval. These findings are discussed below in light of frameworks and theories developed for languages other than Arabic.

4.1 Access to syntax during lexical retrieval

Nouns produced with the determiner (definite article /əl-/ 'the') were produced faster and more accurately than their counterparts produced without the determiner. The interpretation of the effect of determiner on spoken naming of nouns in P1, P2 and P3 can be best understood within the 2-step Interactive Model (Dell et al., 1997), and the Weaver++ model (Levelt et al., 1999), and less likely interpreted within the Independent Networks model (Caramazza, 1997). According to Dell et al. (1997), the production of the determiner /əl-/ 'the' prior to the noun starts the noun retrieval at the syntactic level and spreads in parallel into phonological and semantic levels, thus providing a syntactic context, within which the target noun is retrieved. After semantic nodes for a given noun have been activated, the activation spreads to the syntactic level interceding between semantics and phonology. This activates all possible syntactic environments that are relevant to the target noun. According to Dell et al. 's (1997) model, the presence of the determiner prior to the target noun creates a jolt of activation caused by the syntactic slot that the selected word is linked to (in this case, it is the determiner + noun slot). This jolt of activation enhances the retrieval of the target noun by an absolute threshold that boosts the activation of a given node. This may account for the facilitated noun retrieval following determiners in the current data (Dell et al., 1997).

Another possible but less likely scenario that we propose, is assuming that the presence of the determiner prior to the noun suppresses competing representations (lemmas). This process may reduce disambiguation and restricts the retrieval process to target representations. Only relevant nodes are activated, which makes spoken naming faster and more accurate; faster, because two interactions may take place simultaneously and more accurate, because competition is reduced with other representations, which results in less chances for errors. However, this assumption requires rigorous investigation before claiming its validity.

P1 and P2 had agrammatic production, resulting in their morpho-syntactic errors on the bare noun condition, but not in the determiner + noun condition, suggesting that the production of determiner prior to the target noun may have constrained the production of morpho-syntactic errors. One could argue that these errors may be caused by phonological impairment in participants P1 and P2, or that they are underlying effect of phoneme length. However, the current pattern of performance indicates that these errors are morpho-syntactic rather than phonological, as they were not present when nouns were preceded by a determiner. Furthermore, if it was a phonological effect, one would assume that the determiner presence would not eliminate such errors. In addition to this, none of the current participants showed a phonological length effect in the multiple regression analysis, suggesting that the lack of morpho-syntactic errors in the second condition is caused by introducing the determiner to the noun phrase in question.

A possible interpretation of participants' performance in the first condition is that the lexical access impairment present in the current participants reduced activation from semantics to the lemma representation of the noun in question, resulting in difficulties in the selection of the target noun and, for example in the selection of a semantically related representation, resulting in morpho-syntactic errors. However, in the second condition, access of the determiner lemma prior to the noun might have resulted in additional activation sent from the determiner lemma to different noun lemma representations. As a result, the pre-activation of noun lemmas, including the target noun lemma boosted their activation levels, so that the activation of the target noun lemma was high enough for its selection once it received semantic activation.

The fact that producing a noun with a determiner led to more accurate and faster naming in Arabic is consistent with recent neuropsychological studies investigating the role of determiner in noun production (e.g. English: Gregory et al., 2010, Herbert and Best, 2010; Maltese: Ritschel, 2009). These studies found that determiners which do not inflect for syntactic information of the following noun facilitated lexical retrieval. The Arabic definite article /əl-/ 'the' is a neutral determiner; it does not inflect for any syntactic properties of the noun it determines, serving only as a marker of definiteness. Despite this, the definite article led to shorter latencies and greater accuracy, which challenges the assumption that determiners can only facilitate lexical retrieval if they inflect for syntactic properties of the noun they determine (e.g. Miozzo and Caramazza, 1999; Schriefers, 1993; Schriefers, Jescheniak and Hantsch, 2002). The results from the current study support the view that agreement presence is not necessary for syntax to be activated as the Arabic definite article does not inflect number or gender.

The facilitation of aphasic lexical retrieval after determiners suggests that retrieval of nouns within a syntactic frames facilitates naming in aphasia. This has implications in aphasia therapy. For example, Gregory et al. (2010) found that the clause + determiner condition made the highest contribution to KW's successful naming. They maintain that anomia therapy incorporating nouns within syntactic contexts enhances therapy effects.

Khwaileh et al. (2014) reported results from the Levantine Arabic normative dataset showing that normative production of bare nouns was not influenced by the underlying morpho-syntactic features of target nouns, suggesting that bare nouns may be retrieved without syntactic influence (see also Schriefers, 1993; Vigilocco et al., 2004). However, results from the current determiner + noun experiment showed a different pattern. The dissociation between the normative and aphasic data arguably suggests that syntactic effect during bare noun retrieval occurs for participants with aphasia but not healthy ones. This conclusion is consistent with the proposal made by Herbert and Best (2010) in which they state "that the evidence provided here supports the claim that syntactic information influences production even for bare nouns, at least for people with aphasia" (p.341). An alternative interpretation is adopted from Herbert et al. (2014) and Vigliocco et al. (2011) who suggest that the activation of syntax operates flexibly dependent on the task demands. In Khwaileh et al. (2014) the task did not demand participants to produce nouns within a syntactic frame, however, in the current study, participants were asked to produce nouns with the determiner resulting in activation of syntax and facilitation of retrieval.

4.2 Predictors of lexical retrieval after aphasia

The effect of psycholinguistic factors on P1, P2 and P3's spoken naming was examined. Age of acquisition, imageability and rationality affected P1's naming. P2's naming was affected by imageability and normative reaction time. P3's naming was influenced by age of acquisition and name agreement. The variability of results from accuracy and reaction time analysis may be a result of the extreme variability and manipulation (transformation) of reaction time data. In the current dataset, accuracy was a more consistent measure of successful spoken naming than reaction time.

P1 was more accurate in naming irrational than rational nouns. This is the first study to find an effect of rationality (a semantic feature of Arabic nouns) on spoken naming. Due to the dichotomous nature of rational and irrational nouns, this could be perceived as an underlying animacy effect. Post-hoc analysis showed that this effect was not due to an animacy effect, but was independent of this factor. Previous literature on English has reported a semantic category effect after brain damage. Much of this research has been dedicated to the case of livings versus non-livings or animate versus inanimate entities (e.g. Best, Schröder and Herbert, 2006; Caramazza and Shelton, 1998; Lambon-Ralph, Patterson, Garrard and Hodges, 2003; Tyler, Moss, Durrant-Peatfield and Levy, 2000; Warrington and Shallice, 1984). For example, participant KH, described in Lambon-Ralph et al. (2003), showed an effect of semantic category (living things vs. artefacts) where he was better in naming artefacts than living things. The authors reported that semantic category was the only factor that significantly predicted successful performance in KH's naming and word to picture matching with the set of pictures from Snodgrass and Vanderwart (1980). Participants with reverse effects have also been reported in literature. For example, Best, Schroder and Herbert (2006) reported that PH (a participant with aphasia) showed a consistent impairment in naming non-living things compared to living things.

As this is the first report on rationality effect in participants with aphasia, models accounting for this effect are not available. An attempt to interpret rationality effect in P1 follows. This interpretation is adopted from previous theories developed to account for dichotomous semantic categories such as living and non living entities. Tyler et al. (2000) suggest that a semantic category effect is reduced to inter-correlated features within members of a given category. In the current study, rational nouns share very close features while irrational nouns have a wider range of features, influencing the density of semantic neighbourhood. Rational nouns have very close semantic features as they are restricted to humans and deities. This increases the number of competitors during the word retrieval process because close semantic competitors are likely to be highly activated. Examples of rational nouns are 'teacher', 'doctor', 'boy' and 'man'. On the other hand, irrational nouns category has a wider range of items, because it encompasses all nouns except humans and deities. Examples of irrational nouns are 'dog', 'book' and 'dignity'. Therefore, it is easier to distinguish between irrational nouns than rational nouns at a lexical retrieval level. As a result, irrational nouns were more resistant to P1's brain damage than rational nouns. Alternatively, the effect of rationality on P1's naming may be a result of the linguistic complexity of this feature. Rationality is a semantic feature with morpho-syntactic implications (irrational masculine plural nouns assign singular feminine modifiers). The effect found in P1 may be a reflection of an underlying morpho-syntactic effect. This suggestion remains open to question, as there is not enough evidence in the current data to support this claim. Providing a robust theory accounting for the rationality effect is beyond the scope of this study. Future studies on Arabic should investigate the rationality effect in depth on both production and comprehension levels to identify the functional locus of this effect.

The effect of rationality on P1's spoken naming shows that language specific effects can be present; rationality is a semantic feature that exists in Arabic, but not in English. Such findings have implications for future research into Arabic aphasia. Future examinations of lexical retrieval in participants with aphasia need to control for rationality and other language specific features.

Words with lower age of acquisition ratings were retrieved faster and more accurately. P1 and P3's performance can be interpreted within two theoretical frameworks. Early acquired words may be more resistant to brain damage, because they have complete phonological forms (Brown and Watson, 1987), while later acquired words are at risk after brain damage. The current findings are in agreement with findings from previous studies which found that age of acquisition was a major predictor of aphasic performance in picture naming tasks (English: Ellis et al., 1996; Hirsh and Ellis, 1994; Nickels and Howard, 1995; French: Kremin et al., 2001; Spanish: Cuetos et al., 2002; Rodriguez-Ferreiro et al., 2009). Nickels and Howard's (1995) stated that the effect of age of acquisition may reflect the fact that early acquired words tend to be highly imageable, highly frequent, short, highly familiar and concrete. Post-hoc analysis of the current data revealed that age of acquisition was still a significant predictor of aphasic spoken naming when imageability was controlled for, which is an indicator to the robustness of age of acquisition effect on lexical retrieval. The fact that P1 and P2 were more successful in retrieving highly imageable words than lower ones can be interpreted within two frameworks. Highly imageable words may be more resistant to brain damage, because they have a greater number of semantic representational nodes (Plaut and Shallice, 1993), and they are coded using both a verbal and a non-verbal code (Paivio, 1991). Studies of other languages (English: Ellis et al., 1996; Marcel and Patterson, 1978; Nickels and Howard, 1995; Richardson, 1975; Warrington, 1981; Warrington and Shallice, 1984; Spanish: Cuetos et al., 2002) suggest that imageability is a significant predictor of aphasic spoken naming which is in agreement with the current findings. However, Rodriguez-Ferreiro et al. (2009) reported a lack of imageability effect on Spanish picture naming which is inconsistent with the current findings and findings from previous studies on Spanish (Cuetos et al., 2002). This variation in findings could be attributed to methodological implications such as types of aetiologies used in studies, or experimental design. Rodriguez-Ferreiro et al. (2009) included participants with Alzheimer Disease whereas Cuetos et al. (2002) and the current study included participants with aphasia following cerebrovascular accidents.

Khwaileh et al. (2014) showed that imageability and age of acquisition were found to be the only significant predictors of lexical in healthy speakers. This indicates that age of acquisition and imageability are essential to lexical retrieval in both healthy and brain-damaged speakers of Arabic.

In P3's naming, words with higher name agreement were more accurately produced than ones with low name agreement. The effect of name agreement in P3's responses can be understood under the framework proposed by Vitkovitch and Tyrell (1995). They proposed that the locus of the name agreement effect is at structural representations level. Words with lower name agreement have more alternative correct names to choose from (Vitkovitch and Tyrell, 1995). These findings are compatible with results from studies of other languages (French: Kremin et al., 2001; Italian: Laiacona et al., 2001; Spanish: Rodriguez-Ferreiro et al., 2009), which found that name agreement was a strong predictor of aphasic picture naming.

The fact that normative reaction times predicted the naming latencies of P2 could be understood under the assumption that normative latencies reflect ease of access to lexical items (Croft, Marshall, Pring and Hardwick, 2011).

The effects of the factors described above are arguably in agreement with the locus of participants' anomia loci. Their neuropsychological profiles suggest that all participants had impaired access to phonological forms from semantics, to varying degrees. The effects of normative reaction time, age of acquisition and name agreement indicate difficulties in lexical access.

The word to picture matching tasks show that all three participants had relatively spared semantic comprehension at word level. In contrast, imageability, a variable associated with semantic level processing, was present in all participants, suggesting difficulties in semantic processing in production. In addition, participants' errors on the first condition picture naming task contain semantic errors as shown in table 4, suggesting semantic impairment at production level. Nevertheless, all participants had reduced semantic errors following the determiner in the second condition (table 4). One could argue that this dissociation between production and comprehension may not necessarily indicate a central semantic deficit, but impaired mapping from semantics to phonological representations of target words in production, since semantic errors can result from other levels of processing (Patient JCU: Howard and Orchard-Lisle, 1984). However, this claim remains arguable, as limited availability of Arabic assessment materials prevented rigorous assessment of semantics in P1, P2 and P3.

None of the participants showed an effect of visual complexity, gender, plural type or word length on spoken naming. The lack of visual complexity effect is in support of previous claims which suggested that participants with aphasia do not have difficulties in picture recognition unless the brain areas responsible for visual processing were injured (e.g. Nickels and Howard, 1995; Rodriguez-Ferreiro et al., 2009). However, the current data is incompatible with findings from other languages in which the presence of a visual complexity effect in the absence of visual processing impairment has been reported (French: Gaillard et al., 1998; Kremin et al., 2001; Italian: Laiacona et al., 2001; Spanish: Cuetos et al., 2002).

The lack of word length effect on aphasic naming is inconsistent with the assumption which postulates that participants with phonological anomia show an effect of word length in spoken word production (Nickels, 1997; Nickels and Howard, 1995; 2004). However, the current findings are in agreement with findings from Kay and Ellis (1987), who reported that EST did not show a length effect on spoken word production despite the fact that his anomia was phonological. They are also consistent with findings from French and Spanish speakers with aphasia who did not show a significant effect of word length (phoneme and syllable numbers) in picture naming (Kremin et al., 2001; Rodriguez-Ferreiro et al., 2009). It is possible that word length has an impact on patients with phonological assembly impairment, or latter stages of phonological processing. The current participants had impairment at earlier levels of phonology and mapping from semantics to the phonological lexicon output.

5. Conclusions

The results reported in the current study suggest that noun phrase syntax may be accessed during lexical retrieval, even when a neutral determiner (the Arabic definite article) is produced with the noun. The current data support a close integration of syntactic and lexical processing in noun retrieval. Furthermore, this data suggest that determiners can facilitate lexical retrieval even if they do not inflect for syntactic properties of the noun they determine, which is inconsistent with findings reported above, from Dutch and Italian.

The data obtained in this study derive from only three aphasic participants and are not so easily generalizable to the entire aphasic population. However, the effect of rationality on P1's lexical retrieval showed that such an effect can be present only in languages that have such feature, i.e. Arabic or Tamil. The effect of rationality on lexical retrieval would be of significant value to future research investigating aphasia and semantic category impairment in Arabic.

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References:

Basso, A. (2003). *Aphasia and its therapy*. Oxford: Oxford University Press.

Best, W. (1995). A reverse length effect in dysphasic naming: when elephant is easier than ant. *Cortex, 31*, 637-652.

Best, W., Schroder, A., Herbert, R. (2006). An investigation of a relative impairment in naming non-living items: theoretical and methodological implications. *Journal of Neurolinguistics*, 19, 96-123.

Boyle, M., and Coelho, C., (1995). Application of Semantic Feature Analysis as a Treatment for Aphasic Dysnomia. *American Journal of Speech-Language Pathology*, 4, 94-98.

Brown, G. D. A., & Watson, F. L. (1987). First in, first out: Word learning age and spoken word frequency as predictors of word familiarity and word naming latency. *Memory and Cognition, 15*, 208-216.

Caramazza, A. (1997). How many levels of processing are there in lexical access?. *Cognitive Neuropsychology, 14*, 177-208.

Caramazza, A., & Hillis, A. E. (1990). Where do semantic errors come from? *Cortex*, *26*, 95-122.

Caramazza, A., & Shelton, R. S. (1998). Domain-specific knowledge systems in the brain: The animate–inanimate distinction. *Journal of Cognitive Neuroscience, 10*, 1–34.

Cleland, A., & Pickering, M. J. (2003). The use of lexical and syntactic information in language production: Evidence from the priming of noun-phrase structure. *Journal of Memory and Language, 49*, 214-230.

Cleveland R. (1963). A classification of the Arabic dialects of Jordan. *Bulletin of the American School of Oriental Research, 167*, 56–63.

Coleman, M. (personal communication). The response Recorder Software [unpublished].

Croft, S., Marshall, J., Pring, T. and Hardwick, M. (2011). Therapy for naming difficulties in bilingual aphasia: which language benefits?. *Int J Lang Commun Disord*, 46(1), 48-62.

Cubelli, R., Lotto, L., Paolieri, D., Girelli, M., & Job, R. (2005). Grammatical gender is selected in bare noun production: Evidence from the picture-word interference paradigm. *Journal of Memory and Language, 53*, 42-59.

Cuetos, F., Aguado, G., Izura, C., Ellis, A. W. (2002). Aphasic naming in Spanish: predictors and errors. *Brain and Language, 82*, 344-365.

Dell, G. S., Schwartz, M. F., Martin, N., Saffran, E. M., & Gagnon, D. A. (1997). Lexical access in aphasic and nonaphasic speakers. *Psychological Review, 104*, 801–838.

Ellis, A. W., & Morrison, C. M. (1998). Real age-of-acquisition effects in lexical retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 24*, 515-523.

Ellis, A. W., Lum, C., & Lambon Ralph, M. A. (1996). On the use of regression techniques for the analysis of single case aphasic data. *Journal of Neurolinguistics, 9*, 165–174.

Friedmann, N., & Biran, M. (2003). When is gender accessed? A study of paraphasias in Hebrew anomia. *Cortex*, *39*, 441-463.

Gaillard, M. J., Girard, C., Lemarchand, M., Eustache, F., & Hannequin, D. (1998). Effet categorie spcifique en dnomination dans la maladie d'Alzheimer. In M. C. Gely-Nargeot, K. Ritchie, & J. Touchon (Eds), *Actualitde 1998 sur la maladie d'AIzheimer et les syndromes apparentds,* (pp. 321- 328). Marseille: Solal.

Gardner, H. (1973). The contribution of operativity to naming capacity in aphasic patients. *Neuropsychologia*, *11*, 213-220.

Gregory, E., Herbert, R., & Varley, R. (2010). Integration of syntax and lexis in anomia therapy. *Procedia Social and Behavioral Sciences*, 6, 258–259.

Herbert, R., Anderson, E., Best, W., & Gregory, E. (2014). Activation of syntax in lexical production in healthy speakers and in aphasia. *Cortex*, 57, 212-226.

Herbert, R. & Best, W. (2010). The role of noun syntax in spoken word production: Evidence from aphasia. *Cortex,* 46, 329-342.

Herbert, R., Best, W., Hickin, J., Howard, D., & Osborne, F. (2008). Measuring lexical retrieval in aphasic conversation: Reliability of a quantitative approach. *Aphasiology*, *22*(2), 184-203.

Herbert, R., Webster, D., Dyson, L. (2012). Effects of syntactic cueing therapy on picture naming and connected speech in acquired aphasia. *Neuropsychological Rehabilitation*, 22, 609-633.

Hirsh, K. W., & Ellis, A. W. (1994). Age of acquisition and aphasia: A case study. *Cognitive Neuropsychology, 11*, 435-458.

Hirsh, K. W., & Funnell, E. (1995). Those old familiar things: age of acquisition, familiarity and lexical access in progressive aphasia. *Journal of Neurolinguistics, 9*, 23–32.

Howard D, and Orchard-Lisle VM. (1984) On the origin of semantic errors in naming; evidence from the case of a global aphasic. *Cognitive Neuropsychology* 1(2), 163-190.

Howard D, Patterson K, Franklin S, Orchard-Lisle V, Morton J. The facilitation of picture naming in aphasia. *Cognitive Neuropsychology* 1985, 2(1), 49-80.

Humphreys, G. W., Riddoch, M. J. & Price, C. J. (1997). Top-down processes in object identification: Evidence from experimental psychology, neuropsychology and functional anatomy. *Philosophical Transactions of the Royal Society, 352*, 1275-1282.

Humphreys, G. W., Riddoch, M. J., & Quinlan, P. T. (1988). Cascade processes in picture identification. *Cognitive Neuropsychology, 5*, 67-103.

Kay, J., & Ellis, A. W. (1987). A cognitive neuropsychological case study of anomia– implications for psychological models of word retrieval. *Brain*, *110*, 613–29.

Khwaileh T., Body, R., & Herbert, R. (2014). A normative database and determinants of lexical retrieval for 186 Arabic nouns: effects of psycholinguistic and morpho-syntactic variables on naming latency. *Journal of Psycholinguistic Research, 43(6), 749-769.*

Khwaileh, T., Body, R., & Herbert, R. (2015). Morpho-syntactic processing of Arabic plurals after aphasia: Dissecting lexical meaning from morpho-syntax within word boundaries*. Cognitive Neuropsychology, 32 (6), 340–367.*

Kremin, H., Perrier, D., De Wilde, M., Le Bayon, A., Corbinau, M., & Lehoux, E. (2001). Age d'acquisition des mots et acces au lexique. *Revue Neurologique*, *157*(3), 120-132.

Kulke, F., & Blanken, G. (2001). Phonological and syntactic influences on semantic misnaming in aphasia. *Aphasiology*, *15*, 3-15.

Laiacona, M., Luzzatti, C., Zonca, G., Guarnaschelli, C., & Capitani, E. (2001). Lexical and semantic factors influencing picture naming in aphasia. *Brain and Cognition, 46*, 184–187.

Laine, M., & Martin, N. (2006). *Anomia: Theoretical and clinical aspects.* Hove: Psychology Press.

Lambon Ralph MA, Patterson K, Garrard P, Hodges J. R. (2003). Semantic dementia with category specificity: A comparative case-series study. *Cognitive Neuropsychology, 20*, 3-6, 307 – 326.

Law, S., Wong, W., Sung, F., & Hon, J. (2006). A study of semantic treatment of three Chinese anomic patients. *Neuropsychological Rehabilitation*, 16, 601—629.

Levelt, W. J. M., Roelofs, A. P. A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences*, *22* (1), 1-37.

Lewis, P. M. (Ed) (2009). *Ethnologue: Languages of the World* (16th ed). Dallas, Tex.: SIL International.

Marcel, A. J., & Patterson, K. (1978). Word recognition and production: Reciprocity in clinical and normal studies. In J. Requin (Ed), *Attention and performance* (VII). Hillsdale, NJ: Erlbaum.

Miller, D., & Ellis, A. W. (1987). Speech and writing errors in "neologistic jargon aphasia": A lexical activation hypothesis. In M. Coltheart, G. Sartori, & R. Job (Eds), *The cognitive neuropsychology of language* (pp. 235-271). Hillsdale, NJ: Erlbaum.

Miozzo, M., & Caramazza, A. (1999). The selection of determiners in noun phrase production. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 25*, 907-922.

Morrison, C. M. (1993). Loci and roles of word age of acquisition and word frequency in lexical processing. Unpublished DPhil thesis. University of York, York, UK.

Morrison, C. M., Ellis, A. W., & Quinlan, P. T. (1992). Age of acquisition, not word frequency, affects object naming, not object recognition. *Memory & Cognition, 20*, 705-714.

Nickels, L. (1997). Spoken word production and its breakdown in aphasia. Hove: Psychology Press.

Nickels, L.A. and Best, W.M. (1996). Therapy for naming disorders (Part I): Principles, puzzles and progress. *Aphasiology,* 10, 21-47.

Nickels, L., & Howard, D. (1995). Aphasic naming: What matters?. *Neuropsychologia*, *33*(10), 1281 1303.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology*, *45*, 255-287.

Patterson, K., & Shewell, C. (1987). Speak and spell: dissociations and wordclass effects. In M. Coltheart, G. Sartori, R. Job, (Eds). *The cognitive neuropsychology of language* (273-294). London: Lawrence Erlbaum.

Plaut, D. C., & Shallice, T. (1993). Perseverative and semantic influences on visual object naming errors in optic aphasia: A connectionist account. *Journal of Cognitive Neuroscience, 5*, 89-117.

Richardson, J. T. E. (1975). The effect of word imageability in acquired dyslexia. *Neuropsychologia*, *13*, 281-288.

Ritschel, T. (2009). *Noun processing in Maltese aphasia*. Unpublished MSc dissertation. The University of Sheffield, Sheffield, UK.

Rodríguez-Ferreiro, J., Davies, R., González-Nosti, M., Barbón, A., & Cuetos, F., (2009). Name agreement, frequency and age of acquisition, but not grammatical class, affect object and action naming in Spanish speaking participants with Alzheimer's disease. *Journal of Neurolinguistics, 22*(1), 37-54.

Schriefers, H. (1992). Lexical access in the production of noun phrases. *Cognition, 45*, 33-54.

Schriefers, H. (1993). Syntactic processes in the production of noun phrases. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19*, 841-850.

Schriefers, H. J., Jescheniak, J. D., & Hantsch, A. (2002). Determiner selection in noun phrase production. *Journal of Experimental Psychology: Learning, Memory and Cognition, 28* (5), 941-950.

Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory, 6*, 174-215.

Tyler, L.K., Moss, H. E., Durrant-Peatfield, M., & Levy, J. (2000). Conceptual structure and the structure of concepts: A distributed account of category-specific deficits. *Brain & Language, 75,* 195-231.

Vigliocco, G., Antonini T., & Garrett, M. F. (1997). Grammatical gender is on the tip of Italian tongues. *Psychological Science, 8*, 314-317.

Vigliocco G, Vinson DP, Druks J, Barber H, Cappa SF. (2011). Nouns and verbs in the brain: A review of behavioural electrophysiological, neuropsychological and imaging studies. *Neuroscience and Biobehavioral Reviews*, *35*, 407-426.

Vitkovitch, M., & Tyrrell, L. (1995). Sources of disagreement in object naming. *Quarterly Journal of Experimental Psychology*, *48A*, 822-848.

Warrington E. K. (1981). Neuropsychological studies of verbal semantic systems. *Philosophical Transactions of the Royal Society for Biological Sciences*, *295*, 411–23.

Warrington, E. K., & Shallice, T. (1979). Semantic access dyslexia. *Brain*, *102*, 43-63.

Zughoul, M. R. (2007). *Studies in Contemporary Arabic-English Socio-Linguistics*. Irbid: Hamada Establishment for University Studies and Publishing and Distribution.

Appendices

Appendix A

Lexical accuracy coding system

1. **Correct response**: this category was scored when participants produced the target response.
    1.1 Correct response in slurred speech: this subcategory was scored when the participant produced the target response in slurred manner of speech.

2. **Visual error**: when participants produced an inaccurate response that shared one or more visual features with the target response. This category consisted of two subcategories:
    2.1 **Visual error where participants give a name of a similar object**, such as saying /tılıfızjʊn/ 'television' instead of /kəmbjʊtər/ 'computer'
    2.2 **Visual error due to a visual distracter in the presented picture**, such as saying a /ʤaıbə/ 'pocket' for a picture of 'trousers with pockets'
3. **Semantic error**: included inaccurate responses where the response shares one or more semantic feature/s with the target picture. This category consisted of seven subcategories:
    3.1 **Semantic super-ordinate error**: production of a semantically related error that is super-ordinate to the target response. Such as producing /haıwæn/ 'animal' instead of /xərʊf/ 'lamb'.
    3.2 **Semantic coordinate error**: when participants produced a semantically coordinate response to the target response. Such as producing /tʊfæhə/ 'apple' instead of /mɔːze/ 'banana'.
    3.3 **Semantic subordinate error:** when participants produced a name of a subordinate object to the target one. Such as producing /hısæn/ 'horse' instead of /haıwæn/ 'animal'.
    3.4 **Semantic associate error**: production of a response that is associated to the target response. Such as producing /dʊxɑːn/ 'smoke' instead of /sıgərə/ 'cigarette'.
    3.5 **Semantic circumlocution error**: production of a description of the target word form rather than producing the target word form itself. This included descriptions with a minimum of one content word form. For example, a participant would produce an utterance like /btıtgəʃər/ 'you peel it' instead of saying /bʊrtʊgæl-ə/ 'orange'.

3.6 **Semantic and visual error**: when participants produced an inaccurate response that shares semantic and visual features with the target word form. Such as, producing /leımʊn/ 'lemon' instead of /bʊrtʊgælə/ 'orange'.

3.7 **Semantic and phonological error**: when participants produced an inaccurate response that shared semantic and phonological (share 50% or above of the phonemes of the target response) features with the target response. Such as producing /hımær/ 'donkey' instead of /hısæn/ 'horse'.

4. **Phonological error**: this category included erroneous responses where the target and the erroneous response share 50% or more phonemes; for example the participants would say *cut* instead of *cup.* This included three error subcategories:

   4.1 **Phonological related real word form**: when participants produced a phonological error that is a real word form. Such as producing /kətəbə/ 'he wrote' instead of /kıtæb/ 'book'

   4.2 **Phonological related non-word form**: production of a phonological error that resulted in a non-word form. Such as producing /gələd/ 'non-word form' instead of /gələm/ 'pen'.

   4.3 **Partial production of the target word form**: production of one syllable or part of the target word form. Such as producing /fʊn/ instead of /tılıfʊn/ 'telephone'.

5. **Other error**: This category included responses that did not fit within any of the categories above. This included three subcategories:

   5.1 **Unrelated word form:** this subcategory was scored if participants produced a real word form that is visually, semantically and phonologically unrelated to the target response. Such as producing /mısmær/ 'nail' instead of /wərəg/ 'paper'.

   5.2 **Unrelated non-word form**: production of a non-word form that is phonologically unrelated to the target response. Such as producing /kəbɜ:l/ 'non-word form' instead of /fær/ 'mouse'.

5.3 **Unintelligible response**: production of an intelligible response instead of the target response.

6. **Morpho-syntactic error**: production of the target consonantal root with a morpho-syntactic error. This included two main subcategories:
   6.1 **Inflectional error**: This subcategory was scored if a participant's inaccurate response was presented with an inflectional error. This was scored if the incorrect number or gender inflections were present. Such as producing /kʊtʊb/ [plural-noun] 'books' instead of /kɪtæb/ [singular-noun] 'book' or /mʊmərɪð/ [masculine-noun] 'male nurse' instead of /mʊmərɪðə/ [feminine-noun] 'female nurse'.
   6.2 **Derivational error**: this subcategory was scored if the participant's inaccurate response was presented with a derivational error, such as producing an adjective or a verb derived from the same consonantal root of the target response. An example of this would be producing / bʊrtʊgæl-i/ [adjective] 'orange-adjective' instead of /bʊrtʊgæl-ə / 'an orange'.

7. **No response**: this category was scored when participants took more than 20 seconds (from the moment the stimulus was presented) to respond.

Table 1: Aphasia assessment results

Category of subtest	Subtest	P1		P2		P3		Norm*: mean (range)
		Raw score	(%)	Raw score	(%)	Raw score	(%)	
Lexical retrieval	Picture naming (n=24)	6	0.25	15	0.63	14	0.58	23.3 (21-24)
Input processing	Auditory minimal pairs discrimination (n=10)	4	0.40	10	1.00	8	0.80	Not available
	Auditory lexical decision (n=12)	7	0.58	12	1.00	11	0.92	Not available
	Visual lexical decision (n=15)	14	0.93	14	0.93	10	0.67	Not available
Semantic processing	Spoken word to picture matching (n=15)	14	0.93	14	0.93	13	0.87	14.7 (13-15)
	Written word to picture matching (n=15)	12	0.80	14	0.93	14	0.93	14.9 (14-15)
Output processing	Reading aloud of words (n=24)	4	0.17	20	0.84	19	0.79	23.7 (22-24)

	Repetition of words (n=16)	13	0.81	16	1.00	12	0.75	15.9 (15-16)
	Reading aloud of non-words (n=5)	0	0.00	1	0.20	1	0.20	4.7 (3-5)
	Repetition of non-words (n=5)	1	0.20	3	0.60	1	0.20	4.7 (2-5)
Syntactic processing	Spoken sentence to picture matching (n=16)	8	0.50	15	0.94	12	0.75	15.3 (14-16)
	Written sentence to picture matching (n=16)	10	0.62	13	0.81	9	0.56	15.2 (12-16)

Table 2: Summary of conversation data

Category	**Subcategory**	**Number of items**		
		P1	**P2**	**P3**
Speech units	N/A	45	113	105
Turns	Total turns	11	15	17
	Substantive turns	3	3	7
	Minimal turns	8	12	10
Content words excluding paraphasias	N/A	17	80	76
Number of nouns	N/A	9	36	25
Errors	Circumlocutions	1	2	0
	Phonological paraphasias	6	6	7

Table 3: Percentage of accurate items on both conditions

Participant	**Bare noun condition** **Proportion**	**Determiner + noun condition** **Proportion**
P1 (n = 180)	42.7%	75%
P2 (n = 175)	60%	92.5%
P3 (n = 170)	75.2%	84.7%

Figure1: Means (in milliseconds) of reaction times

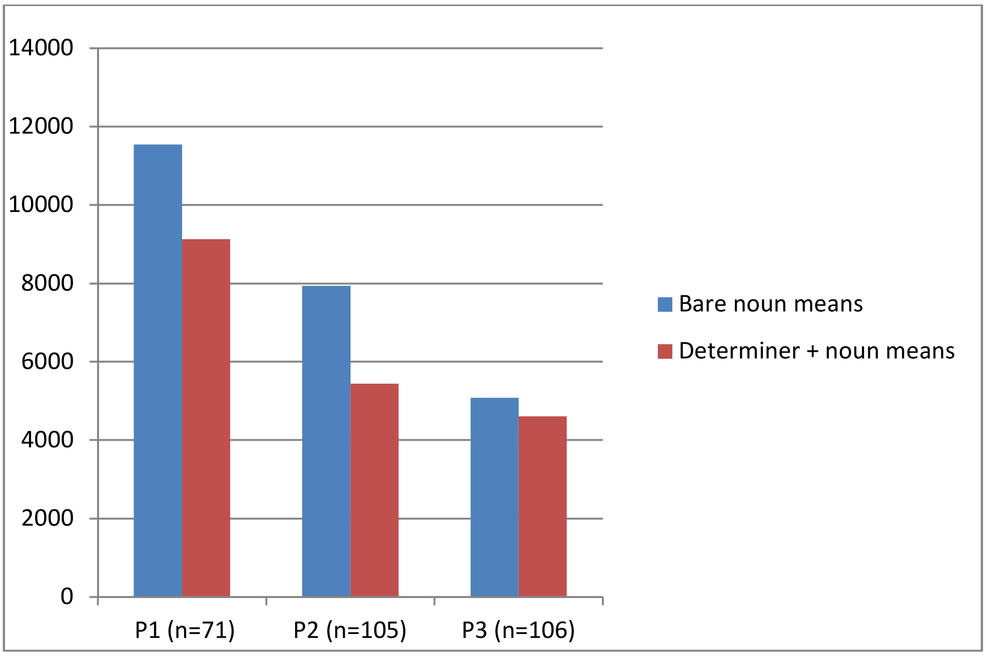

Table 4: Raw scores response categories from both conditions

	P1	P1	P2	P2	P3	P3
Response category	**Bare noun**	**Determiner + noun (n=180)**	**Bare noun**	**Determiner + noun**	**Bare noun**	**Determiner + noun**
Total named	**186**	**180**	**186**	**175**	**186**	**170**
Correct response	**80**	**135**	**105**	**163**	**127**	**144**
Visual	**2**	**0**	**4**	**0**	**4**	**0**
Semantic error	**32**	**5**	**17**	**0**	**32**	**14**
Phonological error	**41**	**31**	**17**	**8**	**15**	**4**
Morpho-syntactic error	**18**	**0**	**15**	**0**	**0**	**0**
Other	**6**	**0**	**2**	**0**	**2**	**0**
No response	**7**	**9**	**26**	**4**	**6**	**8**
Total named	**186**	**180**	**186**	**175**	**186**	**170**
Total errors	**106**	**45**	**81**	**12**	**59**	**26**

Table 5: Relationship between psycholinguistic variables and accuracy

Variable	P1	P2	P3
Visual complexity	.095	-.188**	-.187**
Imageability	.176**	.246**	.150**
Normative reaction time	-.113	-.160**	-.198**
Age of acquisition	-.219**	-.094	-.216**
Name agreement	-.002	-.043	.273**
Phoneme number	-.081	-.038	-.053
Plural type	.102	.022	.018
Rationality	-.151**	.108	.138
Gender	-.090	.057	-.044

**Significance at p<.01

Table 6: Predicting accuracy in participants' lexical retrieval

Participant	Predictor	B	Wald	df	Significance
P1	**Age of acquisition**	-.758	3.815	1	p<.05
	Imageability	1.686	4.893	1	p<.05
	Rationality	-1.470	4.333	1	p<.05
P2	**Imageability**	1.863	6.239	1	P<.05
	Visual complexity	-.817	1.581	1	p>.05
	Normative reaction time	.000	.025	1	p>.05
P3	**Age of acquisition**	-.588	2.362	1	P<.05
	Imageability	.404	.285	1	p>.05
	Name agreement	1.214	9.579	1	p<.05
	Visual complexity	-.680	1.158	1	p>.05
	Normative reaction time	.000	.105	1	p>.05

Table 7: Relationship between psycholinguistic variables and reaction time

Variable	P1	P2	P3
Visual complexity	.088	.086	.030
Imageability	-.112	-.020	-.149
Normative reaction time	-.022	.245**	.085
Age of acquisition	.188	-.046	.255**
Name agreement	-.055	.128	-.003
Phoneme number	-.044	-.183	.059
Plural type	-.127	.100	-.066
Rationality	-.068	.061	.092
Gender	-.011	.028	-.020

**Significance at p<.01