

Agrammatism in Jordanian-Arabic speakers

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(Received 16 July 2011; accepted 18 October 2012)

Abstract

The studies of agrammatism show that not all morpho-syntactic elements are impaired to the same degree and that some of this variation may be due to language-specific differences. This study investigated the production of morpho-syntactic elements in 15 Jordanian-Arabic (JA) speaking individuals with agrammatism and 15 age-matched neurologically healthy individuals. Two experiments were conducted to examine the production of complementizer, tense, agreement and negation morphology in JA. The results indicated that the speakers of JA with agrammatism had marked dissociations in producing specific morpho-syntactic elements. The observed impairment patterns overlapped, in many respects, with those observed in other linguistic groups. The findings are discussed with respect to current theories of agrammatism, including both morpho-syntactic and computational accounts.

Keywords: *Wh questions, tense, agreement, negation, aphasia, cross-linguistic, functional categories, Arabic*

Introduction

Agrammatism is a language disorder characterized by morpho-syntactic impairments affecting the production and comprehension of connected speech. One characteristic of this deficit is the omission and/or substitution of grammatical morphemes. This is seen in constrained tasks and in spontaneous speech (Beeke, Maxim, & Wilkinson, 2008; Goodglass & Menn, 1985). Several accounts have been proposed to explain the varied patterns of performance associated with grammatical morphology. These have included processing (Kolk, 1995, 2000), phonological (Kean, 1977), semantic (Schwartz, Saffran, Fink, Myers, & Martin, 1994) and syntactic (Friedmann & Grodzinsky, 1977; Hagiwara, 1995) accounts.

Recently, neurolinguists have presented the hierarchical structure of syntactic trees, as a possible explanation for the varied patterns of performance observed in agrammatism (Friedmann, 2001; Hagiwara, 1995). For example, in a series of studies examining syntactic elements in Hebrew and Palestinian Arabic, Friedmann (1998, 2001, 2002) found a hierarchical pattern of impairment in which complementizers were more impaired than verb tense inflections, and verb tense inflections

were more impaired than verb agreement inflections. Since this hierarchical ordering of impairment reflected the syntactic tree structure as proposed by Pollock (1989), Friedmann formulated The Tree Pruning Hypothesis (TPH) to account for agrammatic production deficits. According to TPH, the upper (complementizer and tense) projections of the syntactic tree are more impaired relative to lower (agreement and negation) projections. Moreover, impairment at a lower structural level necessitates impairments at all higher levels. For example, if the tense phrase is impaired, the higher complementizer phrase (CP) must also be affected because of its higher position.

Several problems have been associated with hierarchical accounts, such as TPH. One controversial issue in syntactic theory is the hierarchical ordering of syntactic projections. For instance, the relative ordering of tense and agreement projections has been questioned (Diouny, 2007). A second debate centers on whether tense and agreement are represented as separate phrasal units (Wenzlaff & Clahsen, 2004). In the more recent Minimalist Program (MP; Chomsky, 1995, 2000), tense and agreement are included within a single phrasal representation. It is unclear how TPH could explain dissociations between tense and agreement in this context. Furthermore, although several studies have provided evidence supporting the TPH predictions (Benedet, Christiansen, & Goodglass, 1998; Ferrerio, 2003; Kolk, 2000), other studies have provided evidence which is contrary to TPH predictions. For example, cases have been reported in which processing of tense morphology is more impaired than processing of complementizer morphology (Arabatzis & Edwards, 2002; Lee, Milman, & Thompson, 2005). Similarly, cases have been reported in which processing of agreement morphology is more impaired than processing of tense morphology (Burchert, Swoboda-Moll, & De Bleser, 2005). Both these findings are opposite to the predictions made by TPH.

A number of alternate accounts focusing specifically on verb inflections have been proposed. An advantage of these accounts is that they do not depend on a fixed hierarchical order. Rather, they focus on particular properties of tense and agreement morphemes. For example, in the Diacritical Encoding and Retrieval (DER) hypothesis, Faroqi-Shah and Thompson (2007) differentiate morpho-semantic and morpho-syntactic aspects of tense processing. In the case of morpho-semantic processing, tense is selected based on lexical semantic information (yesterday, today, tomorrow), whereas for morpho-syntactic processing, tense is selected based on existing syntactic cues associated with the verb phrase (has, is, will). According to DER hypothesis, individuals with agrammatism have particular difficulty encoding morpho-semantic as compared to morpho-syntactic aspects of tense (Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2010).

Another account, the Tense Underspecification Hypothesis (TUH, Wenzlaff & Clahsen, 2004, 2005) explains tense processing deficits within the context of the MP (Chomsky, 2000). According to TUH, specific syntactic features associated with tense and agreement inflectional processing account for the selective deficits associated with tense processing in agrammatism. The Tense–Agreement Under-specification hypothesis (TAUH, Burchert et al., 2005) is similar to TUH in that it is also based on the MP and syntactic features associated with tense and agreement. However, in light of the double dissociations that have been reported for tense and agreement marking, TAUH asserts that either tense and/or agreement features may be selectively impaired.

The observed variability in performance across individuals with agrammatism and across tasks suggests that no single factor or morpho-syntactic component can account for all of the observed deficits associated with agrammatism. This led Milman, Dickey, and Thompson (2008) to investigate whether discrepancies between various syntactic levels could be explained within a probabilistic framework. Based on a review of the literature and statistical modeling of their own data, they proposed that a hierarchical impairment pattern characterized production in most cases. However, this impairment was probabilistic rather than deterministic in nature. In other words, a deficit at a certain level did not necessarily entail deficits at higher levels, rather it increased the likelihood of their occurrence.

Aims and rationale for current study

It seems likely that at least some of the variability observed in the above studies may be due to language-specific differences. Previous research has examined morpho-syntactic deficits in Japanese (Hagiwara, 1995), Hebrew (Friedmann, 1998, 2001, 2002; Friedmann & Grodzinsky, 1997), English (Arabatzis & Edwards, 2002; Milman, Dickey, & Thompson, 2004, 2008), German (Burchert et al., 2005; Wenzlaff & Clahsen, 2004), Spanish (Benedet et al., 1998), Greek (Stavrakaki & Kouvara, 2003), Dutch (Ruigendijk, Kouwenberg, & Friedmann, 2004), Korean (Lee, 2003) and Turkish (Yarbay Duman & Bastiaanse, 2009). Although agrammatic data have been presented from a variety of languages, very little information is available for agrammatism in Arabic. Nonetheless, there are a handful of studies that have examined Hijazi Arabic (Safi-Stagni, 1992), Palestinian Arabic (Friedmann, 1998, 2002), Algerian Arabic (Mimouni, 1997; Mimouni & Jarema, 1997) and Moroccan Arabic (Diouny, 2007, 2010). To date, there have been no published studies examining Jordanian Arabic (JA).

Notably, the JA serves as an excellent testing ground for agrammatism because of its relatively free word order and strong inflectional system (Abdel-Jawad, 1986; Al-Momani & Al-Saidat, 2010). A brief overview of these features of JA is provided in Appendix 1. These characteristics of JA are particularly evident when compared with languages (such as English) that are characterized by a relatively fixed word order and a weaker inflectional system (Abdel-Jawad, 1986). Moreover, investigating agrammatic features in JA is especially interesting in light of similarities with other Semitic languages (such as Hebrew) and its differences from non-Semitic languages (such as English and German). Finally, given the morphological richness of JA, speakers may find it particularly difficult to produce/process grammatical markers.

The goals of the current study were to (a) examine the production of grammatical morphology associated with different levels of hierarchical structure in JA and (b) evaluate whether impairment patterns observed in other studies and other languages were also evident in JA. In the first experiment, we examined the production of complementizers using a question production task. In experiment 2, we examined the production of verb tense inflection, verb agreement inflection and negation using a sentence completion task.

Method*Participants*

Fifteen native JA speakers with agrammatism (experimental group) and 15 neurologically normal native JA speakers (control group) participated in this study. Participants comprised a cross-sectional representation of the general population of Amman, Jordan and included individuals of Jordanian, Palestinian, Chechnyan and Sharkas origins. Participants were recruited from the Speech and Language Clinic at King Hussein Medical City.

The experimental group (nine males and six females), ranged in age from 40 to 80 years (female mean = 56.7, SD = 10.5; male mean = 62.3, SD = 13.8), were premorbidly right-handed, native monolingual speakers of JA and demonstrated good visual and hearing acuity. Their level of education ranged from 0 to 14 years (female mean = 7.5, SD = 6.3; male mean = 7.9, SD = 5.51). Demographic (gender, age and education) and clinical information (handedness, months post onset, hemiplegia and severity of aphasia) for each patient are presented in Table 1.

The diagnosis of agrammatism was based on the results of the Bilingual Aphasia Test, Arabic, Jordanian (BAT; Paradis & Libben, 1987), language sample analysis and expert clinical opinion of the speech-language pathologist. The severity of agrammatism was determined by clinical ratings based on the performance on the above measures and specifically the following subtests

Table 1. Demographic and diagnostic information for participants with agrammatism.

Subject	Gender	Age	Education (years)	Handedness	Months post-onset	Hemiplegia	Severity as determined by clinical rating and bilingual aphasia test (Paradis & Libben, 1987)
P4	M	70	7	Right	216	Right	Mild
P6	M	70	5	Right	15	Right	Mild
P10	F	47	14	Right	36	Right	Mild
P13	M	52	8	Right	36	Right	Mild
P2	M	54	14	Right	108	Right	Moderate
P8	M	45	10	Right	13	Right	Moderate
P14	F	64	0	Right	24	Right	Moderate
P15	F	40	14	Right	12	Right	Moderate
P1	M	45	13	Right	60	Right	Severe
P3	F	61	9	Right	28	Right	Severe
P5	M	65	14	Right	3	Right	Severe
P7	F	65	0	Right	12	Right	Severe
P9	M	80	0	Right	6	Right	Severe
P11	M	80	0	Right	36	Right	Severe
P12	F	63	8	Right	84	Right	Severe
Means		60.06	7.73		45.93		

taken from the short version of the BAT (for details, see Paradis & Libben, 1987): spontaneous speech, pointing, simple and semi-complex commands, verbal auditory discrimination, syntactic comprehension, synonyms, antonyms, repetition of words, repetition of sentences, series, naming, sentence construction, semantic opposites and listening comprehension. Since some of our participants were illiterate, reading and writing sections of the BAT (Paradis & Libben, 1987) were not implemented. Unfortunately, only the diagnostic classification information and the overall severity score were available at the time of the study. Of the 15 participants, 4 were rated as mild, 4 were rated as moderate and 7 were rated as severe (see Table 1). Participants showed relatively well-preserved language comprehension based on the BAT (Paradis & Libben, 1987). Dysarthria and apraxia were evaluated by a clinically certified Speech Language Pathologist with 7 years of experience working with adults in a medical setting and found to be mild or non-existent.

The control group included 15 neurologically intact participants who were matched on a one-to-one basis with the agrammatic participants for age (female mean = 56.7, SD = 10.5; male mean = 62.3, SD = 13.8), educational level (female mean = 7.5, SD = 6.3; male mean = 7.9, SD = 5.51), gender (nine males and six females), job level and dialect. Data from the control group were used to establish scores that served as norms to assess the performance of the agrammatic group.

General data collection procedures

All participants were tested individually in a quiet environment. Informed consent and assessment protocol procedures were approved by the institutional review board of King Hussein Medical City, where this study was conducted. All data were collected by a speech-language pathologist who was experienced in diagnosing and treating this group of patients. Data collection was subject-paced and therefore the total time required to complete data collection varied somewhat across participants. In the majority of cases, data collection was completed in three 1-hour sessions at the Speech and Language Clinic at King Hussein Medical City. However, six participants required an additional

1-hour testing session, which was completed at the participant's home. All sessions were audio-recorded and then transcribed by the examiner.

Data transformation

Binomially distributed data ("0" or "1" responses) were collected in this study. Since the homogeneity of variance (a prerequisite for ANOVA) cannot be assumed in a binomial distribution, raw scores were transformed into rationalized arcsine unit (rau) scores (Studebaker, 1985) and were entered into SPSS for statistical analysis (standard version 14; SPSS Corporation, Chicago, IL, USA). This transformation served to normalize the distribution and allows the ANOVA statistical tests described below. We added qualitative analysis (error analysis) to each experiment. Partial correlation was conducted to assess whether performance on two experiments was affected by the overall severity level.

Coding reliability

An independent coder transcribed and coded 20% of the data (three individuals from both participant groups) using audio tapes from the two experiments. Intercoder point-to-point reliability was then calculated. Overall agreement for experiment 1 ranged from 95 to 100% with an overall mean of 98%. Overall agreement for experiment 2 ranged from 97 to 100% with an overall mean of 99%.

Experiment 1: question production task

Experiment 1 investigated the production of complementizers using a question elicitation task. Specifically, we compared Wh question production (complementizer required) and yes/no question production (no complementizer required). The question elicitation task was an adaptation of Friedmann's (2002) task.

Stimuli. A total of 36 target questions were developed. These included: (1) Wh argument questions ($n = 12$), (2) Wh adjunct questions ($n = 12$) and (3) yes/no questions ($n = 12$). Sentences ranged in length from three to four words and included: a subject or object noun, verb and preposition or article when necessary. In addition, Wh questions included a Wh-morpheme, whereas yes/no questions were marked by a rising intonation pattern. The same verbs were used in all three question types. All sentences were presented in the affirmative and conjugated for third person singular agreement. Because we predicted that participants' performance would be affected by tense form, half of the sentences (for all three question types) were presented in the perfective (requiring tense specification) and half of the sentences were presented in the imperfective (not requiring tense specification) tense. An example of each of the three target question types is shown below. See Appendix 2 for additional examples.

1. *Wh argument questions (sentence 1):* The 12 argument questions included 4 questions to elicit the subject (who), 4 questions to elicit the animate object (who) and 4 questions to elicit the inanimate object (what).

An example of an argument (inanimate object) question:

(1) šu ʔakal ɟali

What eat.past-3ms Ali.ms

'What did Ali eat'?

(2) *Wh adjunct questions (sentence 2):* The 12 adjunct questions included 4 questions to elicit where, 4 questions to elicit when and 4 questions to elicit why.

(2) le:š ʔal- ʔawlad bi-yurkuđu

Why def- boys asp-running

'Why are the boys running'?2.

(3)Yes/no questions (sentence 3): There were 12 yes/no questions as exemplified below.

An example of a yes/no question:

(3) çali raħ lil- madrasi?

Ali.ms go. past -3ms to- school ?

'Did Ali go to the school'?An example of an adjunct question:

Procedures. Questions were elicited by presenting a sentence containing a subject, verb and direct object. The participant was then prompted to ask about the subject, object, place, cause or time in the statement. Examples of prompts used to elicit Wh questions and yes/no questions are shown below.

Examiner prompt for Wh-question: Ali ate an apple. You want to know about the thing that he ate so you ask... (target response: What did Ali eat?)

Examiner prompt for yes/no question: Ali was sick yesterday. You want to know if he went to school, so you ask... (target response: Did Ali go to school?)

Participants were given examples of each question type until they understood the task. Once the experiment began, the examiner did not provide any additional feedback. There were no time constraints to complete the task. The Wh questions and yes/no questions were presented in alternating order for each type of question to eliminate any potential order effects.

Scoring criteria. A correct "+" score was assigned to questions that were syntactically and semantically correct and contained the target morphemes. Target morphemes included the Wh morpheme, subject or object noun (either the name provided in the example or an appropriate pronoun), verb (either the target or a semantically appropriate synonym), inflections for tense, person, gender and number agreement, and preposition or article when necessary. Items were also scored as correct if additional elements were added as long as these elements were still semantically and syntactically appropriate. Incorrect responses included omission or substitution errors involving the target morphemes (Wh-morpheme, subject or object noun, verb and inflections for tense, person, gender and number agreement, and preposition or article). Other error types included: do not know responses, incorrect question type (i.e. Wh-question produced as a yes/no question or yes/no question without raising intonation) and production of declarative instead of interrogative sentences. See Appendix 2 for scoring examples.

Analyses. An independent-measures *t*-test was used to decide whether there was a significant difference between the control (neurologically healthy participants) and experimental (individuals with agrammatism) groups. A single factor repeated-measures analysis of variance (ANOVA) was used to test for mean differences among the three question types in the experimental group. Error analysis was performed to further characterize the pattern of deficits in each question type and to tally complementizer and verb inflection errors.

Experiment 2: sentence completion task

The goal of this experiment was to investigate the production of verb tense inflection, verb agreement inflection and negation markers using a sentence completion task. The sentence elicitation task was an adaptation of Friedmann and Grodzinsky's study (1997).

Stimuli. A total of 57 sentences were developed. These included 19 tense sentences, 19 agreement sentences and 19 negation sentences. Sentence length was balanced across the three conditions. All

target sentences ranged from three to four words in length and included: (a) a temporal adverb or negation marker (to prompt positive or negative valence perfective or imperfective verb forms), (b) subject noun, (c) verb and (d) object noun as exemplified in sentences 4–6.

Nineteen (perfective positive) sentences with tense inflection omitted were used to assess tense production. A pre-posed temporal adverb (yesterday) was used to prompt past tense. An example of a past tense prompt with the target response is shown in (4).

(4) Sentence completion (tense)

Examiner prompt: Ali is eating an apple. He did the same action yesterday so you say...

ʔimba:riḥ ḥuwa... tufaḥa

'Yesterday he ... an apple'.

Target response: Ali ate an apple. (ʔa-kal-a: T inflection-ate-Agr inflection).

Nineteen stimuli that included a balanced number of perfective and imperfective positive sentences with agreement inflection omitted were used to examine agreement inflections (see example 5). A pre-posed temporal adverb (yesterday/today) was used to prompt agreement morphological contrast in perfective (requiring tense morpheme) versus imperfective (not requiring tense morpheme) verb forms.

(5) Sentence completion (agreement imperfective form)

Examiner prompt: Yesterday, the girl wrote a letter. She is doing the same action today so you say...

ʔil-yawm ʔil- bint...risala

Today def- girl...letter

Target response: The girl writes a letter (ta-ktub: Agre inflection (fs)-writes)

Nineteen stimuli were used to examine the production of negation. An equal number of sentences were presented in perfective and imperfective forms. Affirmative forms of sentences were used to prompt the negative counterpart as illustrated in example (6).

(6) Sentence completion (negation)

Examiner prompt: The man is watching the TV. You want to make this sentence negative so you say...

ḥuwa ma- bi- yiṢahid- iṢ tilfaaz

pronoun neg. asp- 3m-watch- neg TV

Target response: He is not watching TV (ma- bi- yiṢahid- iṢ)

A set of 19 high-frequency pictured verbs were used to develop the target sentences. Since there are no verb frequency studies in JA, we examined frequency data associated with other Arabic dialects and then selected verbs that are typically used in JA. These verbs were selected from the high-frequency Arabic word list (Mahgoub, Hashish, & Hassanein, 1990) and included both transitive and intransitive verbs. See Appendix 2 for additional examples of stimuli.

Procedures. The required task was to produce a sentence containing the missing verb with the appropriate tense, agreement or negation marking. To maximize facilitative cueing for all participants, inflected verbs were elicited by providing visual (action picture and printed sentence without the verb) and auditory prompts. Only a spoken response was required. Specific prompts and target responses for each morpheme are presented in examples (4), (5) and (6).

Participants were given examples of each morpheme type until they understood the task. Once the experiment began, the examiner did not provide any additional feedback. There were no time constraints to complete the task. The tense, agreement and negation sentences were presented in an alternating order for each grammatical morpheme type in order to offset any potential order effects.

Scoring criteria. For all sentences, the response was scored correct “+” if the patient said the required verb (or a semantically appropriate synonym) with the correct tense inflection, agreement inflection and negation particle. The response was scored incorrect “-” if the patient omitted and/or produced an incorrect verb, incorrect verb inflection (tense, person, gender or number) or incorrect negation marking. For examples of types of errors, see Appendix 2.

Analyses. An independent-measures *t*-test was used to determine whether there was a significant difference between neurologically normal participants (control group) and participants with agrammatism (experimental group). A single-factor repeated-measures ANOVA was used to test for mean differences among tense, agreement and negation productions. An error analysis was also performed to characterize error patterns for tense, agreement and negation morphemes.

Results

Experiment 1: question production task

Group differences. The mean score for question production in the agrammatic group was 58% correct (mean rau (Mr) = 57.56, maximum possible score (MPS) = 115.33, SD = 26.63) compared with 95% correct (Mr = 102.39, MPS = 115.33, SD = 12.81) in the control group. The results of an independent-measures *t*-test indicated that this difference was statistically significant ($t(20.144) = -5.876, p < 0.001, d = 0.63$).

Question type. Mean scores for each question type (argument Wh questions, adjunct Wh-questions and yes/no questions) show a general impairment in question production (see Figure 1). The scores for yes/no questions (Mr = 86.67, MPS = 109.94, SD = 25.64) were higher than the scores for argument questions (Mr = 45.66, MPS = 91.21, SD = 35.04) and adjunct questions (Mr = 41.42, MPS = 91.21, SD = 31.65). A single-factor repeated-measures ANOVA revealed a significant main effect for question type (Wh-argument, Wh-adjunct and yes/no question) on the

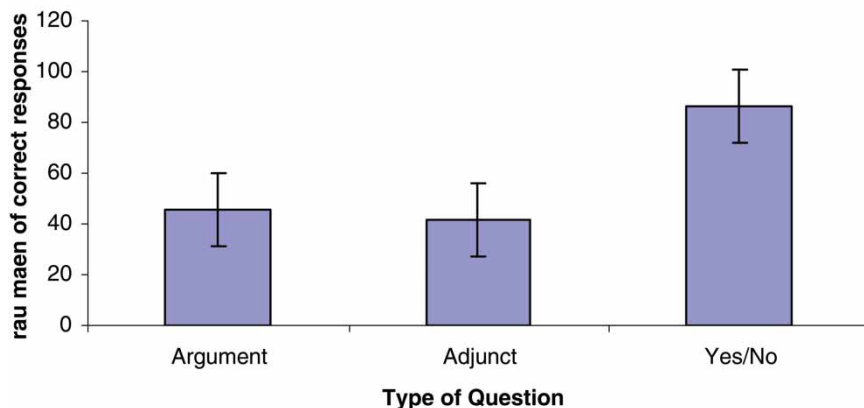


Figure 1. Mean rau scores of agrammatic production on argument, adjunct and yes/no questions.

Table 2. Percent correct of individual participants on morpho-syntactic elements in experiments 1 and 2.

Participants (ordered by score on experiment 1)	Experiment 1				Experiment 2			
	Total for question production (argument and adjunct, yes/no questions)	Argument	Adjunct	Yes/ no	Total for sentence completion	Tense	Agreement	Negation
Participant 4	89	92	83	92	86	84	84	92
Participant 6	86	92	67	100	100	100	100	100
Participant 10	94	92	92	100	90	79	95	100
Participant 13	81	67	75	100	80	47	100	100
Participant 2	61	33	67	83	90	74	100	100
Participant 8	69	75	58	75	98	95	100	100
Participant 14	72	83	33	100	98	95	100	100
Participant 15	69	50	58	100	76	47	89	100
Participant 1	47	33	8	100	66	32	84	92
Participant 3	8	0	0	25	32	32	47	8
Participant 5	14	0	0	42	22	5	53	0
Participant 7	47	33	17	92	92	89	95	92
Participant 9	39	17	17	83	64	47	68	83
Participant 11	42	17	33	75	62	47	89	42
Participant 12	44	17	33	83	56	16	68	100

elicitation task, $F(2, 28) = 36.268, p < 0.001$. Sidak's *post hoc* results for question type indicated significantly higher scores for yes/no questions ($t = 45.26, p < 0.05$) than for argument or adjunct questions. However, no significant difference was found between argument questions and adjunct questions. Table 2 (Experiment 1) shows the total score, and scores on Wh-argument, Wh-adjunct and yes/no questions for each participant in the experimental group.

Error analysis. A total of 199 errors were made on the Wh-question elicitation task and 29 errors were made on yes/no questions. Further analysis was conducted to compare complementizer and verb inflection errors on Wh-question production. Ninety-eight of 199 (49%) of the errors involved both Wh-morphemes and verb inflections. An additional 71/199 (36%) of the errors were characterized by ill-formed Wh-questions with intact verb inflections. Thirty of 199 (15%) of the errors could be classified as well-formed Wh-questions with errors restricted to the verb inflection (see Example 1 in Appendix 2).

Experiment 2: sentence completion task

Seven of the 19 negation items elicited a gestural (head nod) response, rather than a verbal response. To adjust for this unexpected outcome, only negation items producing consistent verbal responses ($n = 12$) were entered into the analyses below.

Group differences. The mean score for the production of morpho-syntactic elements in (tense, agreement and negation) in the agrammatic group was 74% correct ($M_r = 76.72, M_P_S = 116.47, SD = 26.92$) compared with 97% correct ($M_r = 107.96, M_P_S = 116.47, SD = 10.55$) in the control group. An independent-measures *t*-test was used to analyze the results of sentence completion

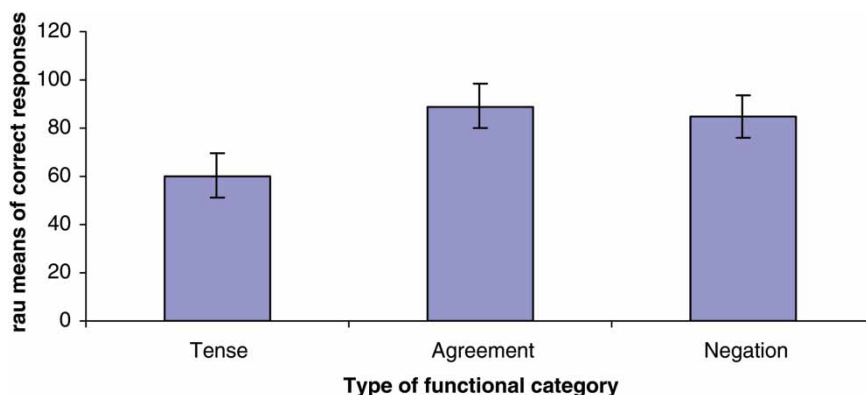


Figure 2. Mean rau scores of agrammatic production on tense, agreement and negation.

task as a function of participant group (normal, agrammatic). The results indicated that this difference was statistically significant ($t(18.207) = -4.184, p < 0.05$).

Morpho-syntactic element type. We investigated if there was a difference in the production of morpho-syntactic elements (tense, agreement and negation) for the experimental group. The mean scores of correct responses on tense inflections, agreement inflections and negation particles are represented in Figure 2.

The results in Figure 2 showed that the deficit in tense production ($M_r = 60.39, M_{PS} = 112.52, SD = 32.29$) was greater than the deficit in both agreement production ($M_r = 89.07, M_{PS} = 112.52, SD = 22.42$) and negation production ($M_r = 85.02, M_{PS} = 109.94, SD = 39.37$). A single-factor repeated-measures ANOVA revealed a significant main effect for morpho-syntactic element type (tense, agreement and negation) on the sentence completion task, $F(2, 28) = 9.625, p < 0.001$. Sidak's *post hoc* results for morpho-syntactic element type indicated that the tense was significantly more impaired than agreement or negation morphemes ($t = 28.68, p < 0.05$). However, the difference between agreement and negation morphemes was not significant. Table 2 (Experiment 2) shows the total score, and scores for tense, agreement and negation for each participant on the sentence completion task.

Error analysis. Errors included omissions and substitutions of one or more grammatical morphemes. There were a total of 114 errors for the tense stimuli. Errors included tense inflection (imperfective for perfective) substitutions (53%), verb substitutions (18%) and verb omissions (29%). For agreement stimuli (half perfective; half imperfective), 73% of the errors occurred when the target sentence was in the perfective form. Agreement errors included omission of the agreement inflection (66%), substitution of the person agreement inflection (16%), substitution of the gender agreement inflection (9%) and substitution of the number agreement inflection (3%). For negation sentences (half perfect, half imperfect sentences), 86% of the errors occurred when the target sentence was in the perfective form. Errors included omissions involving the negation particle and or verb (67%), verb substitutions (3%) and tense inflection (imperfective for perfective) substitutions (30%).

Task complexity and severity level. The performance on both tasks was affected by overall aphasia severity ($r = 0.81; p < 0.01$). Therefore, a cross-experimental task comparison was not performed.

Discussion

The purpose of this study was to investigate the production of morpho-syntactic elements corresponding to question generation, tense, agreement and negation in JA speakers with agrammatism. We accomplished this by using established sentence production tasks. Our results revealed that JA speakers with agrammatism had marked dissociations in producing specific morpho-syntactic elements. The results of the question production task indicated that the production of Wh-questions was significantly more impaired for argument and adjunct Wh-questions than for yes/no question production. The results of the sentence completion task indicated that the production of grammatical morphemes was significantly more impaired for tense inflections than for agreement inflections and negation particles. In the sections below, we discuss these findings in relation to current theories of agrammatism and possible language-specific effects.

Question production. The finding that the production of Wh-questions was significantly more impaired than the production of yes/no questions is in agreement with other studies that have compared these question types in Palestinian Arabic and Hebrew (Friedmann, 2002). The dissociation between the two types of questions can be explained with respect to their structural differences. The production of Wh-questions requires the movement of the Wh-morpheme to the beginning of the sentence and therefore the involvement of complementizer processing, whereas yes/no production in JA does not trigger overt movement and therefore does not involve complementizer processing. Yes/no questions can be produced simply by changing the intonation without any changes in word order.

In keeping with hierarchical accounts, the majority of errors involved the Wh-element (36%) or both the Wh-element and tense inflection (49%). Interestingly, however, the error analysis also showed that (15%) of the total Wh-question production errors included well-formed Wh-questions with tense inflection errors. This observation is against the logic of hierarchical accounts such as TPH, which predict that the impairment at the level of IP automatically necessitates impairment at the higher CP level. This observation can be explained, however, within a probabilistic account which would expect such variability to occur within the context of individual differences and other factors contributing to the full spectrum of language deficits.

Production of tense, agreement and negation morphemes. The finding that the production of tense inflections was significantly more impaired than the production of agreement inflections and negation particles is consistent with a variety of current theories pointing to tense-specific deficits in agrammatism. For instance, the predictions of the DER hypothesis are borne out clearly in this study. All stimuli examining tense inflections demanded morpho-semantic processing. Specifically, all stimuli were preceded by a temporal adverb (yesterday). This order is relevant to DER, which predicts particular difficulty in producing and interpreting sentences with pre-posed adverbs (Faroqi-Shah & Dickey, 2009; Faroqi-Shah & Thompson, 2010).

The selective deficit associated with tense (vs. agreement or negation) production is also consistent with the TPH (Friedmann, 1998, 2001, 2002) and TUH (Wenzlaff & Clahsen, 2004, 2005). Importantly, however, there were several exceptions to a hierarchical relationship. Although all of the participants had equal (2/15) or lower scores (13/15) on tense elicitation than on agreement elicitation, 4 of the 15 individuals had lower scores on negation (column 8) than on agreement (column 7) elicitation. These counter examples lend support to less deterministic accounts, such as the probabilistic model (Milman et al., 2008) or the TAUH (Burchert et al. 2005), which allow for deficit patterns that may violate a rigid hierarchical model.

The contrast between performance on perfective versus imperfective tense forms is vital for understanding tense deficits in JA agrammatism. The perfective is fully specified for tense, while the

imperfective is not. We predicted that the perfective would be more impaired than the imperfective form, since the perfective form obligatorily marks (past) tense. Our findings showed that the production of the perfective form was consistently less accurate than the production of the imperfective form. In fact, the error analyses revealed that verb inflection substitution errors typically entailed use of the imperfective in place of the perfective form. These findings provide strong evidence that tense is particularly vulnerable to impairment in JA agrammatism. As stated above, this outcome is in line with a large body of cross-linguistic research and several theoretical accounts pointing to tense-specific deficits in agrammatism.

Syntactic vs. processing accounts of agrammatism. The results of this study showed that elements associated with complementizer (Wh-questions) and tense morphology are often impaired relative to other morpho-syntactic structures (agreement and negation). However, given the specific morpho-syntactic properties of JA, it is important to recognize that these findings may also be explained with respect to a processing account of agrammatism (Kok, van Doorn, & Kolk, 2007). Speakers may find it particularly difficult to produce Wh-questions because of their inherent complexity. Wh-question formulation in JA requires production of an additional morpheme and a change in word order, both of which are not required for yes/no question formulation. Moreover, it could be argued that producing the perfective is more difficult than producing the imperfective simply because the perfective form obligatorily requires an additional level of (tense) morphological processing. Differentiating between the validity of these competing theoretical models remains a question for future research.

Task complexity and severity level. While it is tempting to compare the performance on the two experiments, it is important to realize that the two tasks varied greatly in difficulty with respect to basic computational demands (producing an entire sentence in Experiment 1 versus completing a sentence fragment in Experiment 2). Since performance on both tasks was affected by overall aphasia severity ($r = 0.81$; $p < 0.01$), it is likely that both task complexity and morpho-syntactic complexity contributed to differences in performance across the two experiments. Therefore, a cross-experimental task comparison was not performed.

Clinical implications. Findings from this research have important clinical implications. The complex relations and differences that exist across morpho-syntactic elements suggest that assessment and treatment plans should target specific morphemes. For example, in JA, as has been demonstrated for several other languages, elements associated with complementizer and tense morphology are often impaired relative to other morpho-syntactic structures. Therefore, these morphemes should be evaluated as potential targets for intervention. Since perfective form is likely to be more impaired than imperfective form in JA, targeting this form might also be a priority in selecting treatment goals. Furthermore, in line with DER the difficulty demonstrated by our participants in producing sentences with pre-posed adverbs (yesterday) suggests that it may be advantageous to develop treatments that target morpho-semantic versus morpho-syntactic aspects of tense processing. Lastly, the observed variability between and within participants and tasks and across morpho-syntactic elements suggests that intervention plans should target specific patient performance profiles and individual levels of severity. Clearly, these treatment suggestions are speculative and should be tested explicitly in formal treatment studies.

Summary and conclusions

In this study, the production of morpho-syntactic elements was investigated in a relatively large sample of JA speakers with agrammatism. The types and variability of errors noted among agrammatic speakers in this study were similar to the variation of inflectional errors observed in agrammatic speakers in similar semitic languages such as Hebrew and Palestinian Arabic as well

as in other languages. Based on the findings reported here and a review of the literature to date, it seems likely that multiple variables encompassing both syntactic complexity and computational load contribute to the various manifestations of agrammatism observed in JA and in other languages.

Declaration of Interest: The authors report no conflict of interest.

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Appendix 1. Jordanian-Arabic verbal paradigms and clausal structure

Verbal paradigms and clause structure in Jordanian Arabic (JA)

Verbs in JA are marked for person, number, gender and tense/aspect. In JA number, agreement between the verb and the subject is realized by an affix, regardless of word order as shown in sentence (1) that also shows free word order in JA.

Examples of free word order:

- (1) ?al-?awla:d ?akalu
 def-boys eat.past-3mp
 'The children ate'
 ?akalu ?al-?awla:d
 eat.past-3mp def-boys
 'The children ate'

Also, in JA, the verb carries full agreement regardless of the position of the subject with respect to the auxiliary verb and the main verb as illustrated in sentence (2). The examples of agreement markers:

- (2) ka:nat ? al-bana:t ta:kul
 be.past.3fs def-student 3fs-eat
 'The students were eating'
 ?al-bana:t ka:nt ta:kul
 def-student be.past.3fs 3fs-eat
 'The students were eating'

The verb has two aspect-tenses: perfective/past (sentence 3) and imperfective/non-past (sentence 4). There has been a long running controversy within Arabic syntax and morphology concerning the classification of tense and aspect morphology. Importantly, the features of tense (T) are not the same in Arabic and in English. Chomsky (1995) proposes that tense (T) in English is specified for two categorical features: [+V] that determines the interaction between the tense and the verb, and the feature [+D] that determines the interaction between the subject and the verb. For Arabic, the perfective is specified for both past tense [+V] and agreement [+D], whereas the imperfective is specified only for agreement [+D] because it is considered the default verb form in Arabic (Benmamoun, 1999).

Examples of verbal paradigms in JA:

(3) katab-tu
Write.past-1s'I wrote'

(4) ?a-ktub -u
1s-write-present/ind
'I write / I am writing'

Notably, agreement features are marked differently in perfective and imperfective forms. In the imperfective form, agreement features are realized by both prefixes and suffixes to express subject-verb agreement. In the perfective form, all the agreement morphologies are realized by suffixes that also carry past tense features. However, the same suffix agreement used in perfective/past can also be used in imperfective/non-past. Therefore, these suffixes are not overt and they do not realize past tense by themselves.

JA has fewer paradigms than in Standard Arabic (Abdel-Jawad, 1986; Al-Momani & Al-Saidat, 2010). Specifically, there are no distinctions of mood or case, at least morphologically. Also there are no dual or gender distinctions in the plural forms. The complete verbal paradigms for perfective and imperfective forms in JA are illustrated in the following tables:

1.1. Jordanian-Arabic perfective

Person	Number	Gender	Affix	Verb + affix
1	Singular	F/M	-t	katabt
2	Singular	M	-t	katabt
2	Singular	F	-ti	katabti
3	Singular	M	-∅	katab
3	Singular	F	-it	katabit
1	Plural	F/M	-na	katabna
2	Plural	F/M	-tu	kababtu
3	Plural	F/M	-u	kababu

1.2. Jordanian-Arabic imperfective

Person	Number	Gender	Affix	Affix + Verb
1	Singular	F/M	?a-	?aktub
2	Singular	M	tu-	tuktub
2	Singular	F	tu-i	tuktutbi
3	Singular	M	yi-	yiktub
3	Singular	F	ti-	tiktub
1	Plural	F/M	Ni-	niktub
2	Plural	F/M	ti-u	tiktubu
3	Plural	F/M	yi-u	yiktubu

Negation in JA

Sentential negation is realized by two morphemes, the proclitic /ma/ (which precedes the verb) and the enclitic /s/ (which follows the verb). These two morphemes may occur together (see sentence 5) or in isolation (see sentence 6) (Benmamoun, 2000).

Examples:

(5) ma- ra:ħat- § laila
Neg-go.past.3fs- neg Laila
'Laila didn't go'.

(6) ma- bad- i
Neg- want- my
'I don't want'.

In the perfective form, the merger of the verb with negation is obligatory (see sentence 5). However, in the imperfective form, the merger of verb with negation is optional (see sentences 7 and 8). Examples

(7) ma- bi- yi-ktib- § (8) m- iš bi - yi-ktib
Neg- asp- 3m-write neg neg-neg asp- 3m-write
'He isn't writing'. 'He isn't writing'.

1.3 *Wh-* and *yes/no* question production in JA:

A further characteristic of JA relevant to this study concerns the discrepancy between *Wh* and *yes/no* questions. The production of *yes/no* question in JA does not trigger overt movement; it is marked by raising pitch without changes in word order. The production of *Wh*-questions requires *Wh*-movement to the beginning of the sentence (Al-Momani & Al-Saidat, 2010). Therefore, Spec of CP must be available as a landing site for moved phrases. The movement of *Wh* morpheme is exemplified in (9), (10) and (11). The *Wh* question in (9) is formed from (10) by means of *Wh* morpheme movement to spec-CP, which leaves a trace in the base position of the *Wh* morpheme.

- (9) šu: ? al-walad ?akal ti ?
 What def-boy eat.past.3ms ?
 ‘What did the boy eat ?’
- (10) ?al-walad ?akal šu: ?
 def-boy eat.past.3ms what ?
- (11) ?al-walad ?akal tufa ħa ?
 def-boy eat.past.3ms apple ?

Appendix 2. Sample of stimuli & scoring criteria

2.1. Experiment 1: question production

Item #	Target response	Participant response	Score (rational)	
<i>Argument Wh-questions</i>				
1	Arabic Morpheme-level translation Literal translation	mi:n ?akal ?al- tufaħa Who eat.past-3ms def-apple “Who ate the apple”?	mi:n ...? Who..? “Who..?”	Incomplete question (e.g. <i>Wh-</i> morpheme only)
<i>Adjunct Wh-questions</i>				
2	Arabic Morpheme-level translation Literal translation	Le:š baka ħali Why cry.past-3ms Ali “Why did Ali cry”?	ħal.. baka ? Did cry.past-3ms “Did he cry?”	Incorrect question type (i.e. <i>Wh</i> -question that is produced as a <i>yes/no</i> question.)
<i>Yes/no questions</i>				
3	Arabic Morpheme-level translation Literal translation	ħali ra:ħ ?il- madras ? ħal raħ ħali lil-madrasi? Ali go.past-3ms def-school Q go.past-3ms Ali to school “Did Ali go to school”?	ra:ħ .. ? go.past-3ms Go..?	Omission error (only a single word produced)

2.2. Experiment 2: Sentence completion tasks

Item #		Target response	Participant response	Score (rational)
<i>Example of tense inflection error</i>				
1	Arabic	ʔimbariḥ ḥuwa ʔakal tufaḥa	ʔimbariḥ .. tufaḥa	Incorrect: production of no verb
	Morpheme-level translation	yesterday he.ms ate an apple	Yesterday apple	
	Literal translation	“Yesterday he ate an apple”	“Yesterday..... apple”	
<i>Example of agreement inflection error</i>				
2	Arabic	ʔimbariḥ ʕali katab risali,	ʔimbariḥ katabat risali,	Incorrect: incorrect agreement (use of feminine instead of masculine inflection)
	Morpheme-level translation	Yesterday Ali write.past-3ms a letter	Yesterday write.past-3fs a letter	
	Literal translation	“Yesterday Ali wrote a letter”	“Yesterday she wrote a letter”	
<i>Example of negation error</i>				
3	Arabic	ʕali ma- raḥ ʔal-madrasi OR ʕali ma- ra:h-iṢ ʔal-madrasi	ʕali raḥ ʔal-madrasi	Incorrect: omission of negation particle
	Morpheme-level translation	Ali neg-go.past.3ms def-school OR Ali neg-go.3ms-neg def-school	Ali go.past.3ms def-school	
	Literal translation	“Ali didn’t go to school”	“Ali went to school”	