TREATMENT FOR VERB INFLECTION IMPAIRMENT IN AGRAMMATISM: AN INVESTIGATION OF TREATMENT TYPE AND STIMULUS TYPE

Introduction

Verb inflection errors, such as *I walking* for *I walked*, are a hallmark feature of agrammatic speech production and have generated considerable theoretical interest during the past decade. A variety of accounts have been proposed to explain verb inflection errors, notably, morphological difficulty with affixation (Ullman et al., 1997), a breakdown of the “syntactic tree” (Friedman & Grodzinsky, 1997), and featural (such as tense and number marking) impairments (Burchert et al., 2005; Faroqi-Shah & Thompson, 2007; Wenzlaff & Clahsen, 2004).

Despite this abundance of empirical investigations and theoretical accounts for verb morphology in agrammatism, there is an appalling dearth of treatment research. From a rehabilitation point of view, it is particularly worthwhile to investigate whether agrammatic individuals receive greater benefits from training (pre-lexical) *morphosemantic* processes such as tense feature specification, or from training (post-lexical) *morphophonological* processes such as affixation. Unfortunately, the findings of previous treatment studies for verb morphology do not answer this question because these studies combined aspects of morphophonological practice and morphosemantic associations (Mitchum & Berndt, 1994; Thompson et al., 2006; Weinrich et al., 1997, 1999). In **study 1**, we compared two treatment approaches, one that specifically targeted morphophonological processes, and another that focused on morphosemantic associations. The *morphophonological* treatment focused on inflectional transformations, affixation, and oral production, while the *morphosemantic* treatment focused on associating tense information with various verb forms (without any oral production). The assumption was that a treatment that directly addresses the underlying impairment is more likely to produce significant treatment and generalization gains when compared to a treatment that does not target the underlying source of verb inflection errors.

Previous treatment studies have reported mixed and rather limited patterns of generalization to untrained verbs. In general, it appears that regular past tense transformations are easily generalized, while irregular verb transformations are not (Mitchum & Berndt, 1994; Weinrich et al., 1997). This raises the question of whether the *type of verb stimuli* used in treatment might influence the extent of generalization. This question cannot be answered from existing outcome data because previous studies either included both regular and irregular verbs in training (Mitchum & Berndt, 1994; Weinrich et al., 1997), or trained only regular verbs without testing generalization to irregular verbs (Balasubramanian & Coady, 1998; Thompson et al., 2006). There are several indicators that the lexical entries of irregular verbs are more "complex" than those of regular verbs: 1) longer reaction times are reported for irregular past generation compared to regulars (Bybee & Slobin, 1982); 2) lexical entries are assumed to include idiosyncratic verb form information for irregulars; and 3) the production of irregulars is assumed to involve *blocking* of the default regularization rule of -*ed* affixation (Marcus et al., 1992). The idea that the regular –*ed* affixation rule is activated and then blocked each time an irregular verb is produced has relevance for treatment of agrammatism. Given that the complexity account for treatment efficacy (CATE, Thompson et al., 2003) predicts automatic generalization to less complex structures when similar but more complex structures are trained, it can be hypothesized that training irregular past tense will automatically generalize to regular past tense, but training regular past tense is unlikely to generalize to regulars. **Study 2** compares the relative generalizability of regular and irregular verbs to untrained verb types in individuals with agrammatic aphasia.

Methods

Participants

A total of nine aphasic individuals[1] who had a single left hemisphere stroke, were at least one year post onset, were primary speakers of English, and had no other complicating neurological history, participated in the study (age range: 37-65 years, three female, education range: 12-20+ years). They were administered a battery of tests including the Western Aphasia Battery (Kertesz, 1982), Object and Action naming battery (Druks & Masterson, 2000), portions of the Boston Diagnostic Aphasia examination (Goodglass et al., 1993), spontaneous speech samples (using Narrative Story Cards, Helm-Estabrooks & Nicholas, 2003), and other tests specifically developed for the purpose of this study (repetition, sentence completion, and picture description of regular and irregular verbs). All participants were diagnosed with non-fluent aphasia[2] and agrammatic speech, had no severe phonological impairments, and demonstrated no significant difference in the production of regular and irregular verbs.

Design

In both studies, participants received individual intensive treatment for about 8 hours/per week over 4-5 sessions per week. Both studies used a single-subject baseline-treatment-maintenance (ABA) design. Production of trained verbs in all three tenses (treatment probes) was tested every session, and generalization to untrained verbs was tested every fourth session. The criterion for termination of treatment was 80% accuracy over 4 consecutive sessions or failure for treatment probe accuracy to improve by more than 10% after 12 sessions, whichever came first. Post-treatment testing included all the pre-treatment tests listed earlier. Maintenance testing

[1] Two participants are currently enrolled in treatment study 2.
[2] As per the WAB, eight participants fit the profile of Broca's aphasia and one participant had Trancortical Motor aphasia (AP2).

for the treatment and generalization probes was done two weeks and two months following the termination of treatment.

Stimuli

Black and white line drawings in three tenses were made by an artist for 40 regular (20 training and 20 generalization) and 40 irregular (20 training and 20 generalization) imageable verbs. The irregular verbs included equal numbers of verbs with vowel change (e.g., *sing-sang*) and vowel change + consonant addition (e.g., *sleep-slept*).

Study 1

This study tested the relative efficacy of *morphophonolgical* and *morphosemantic* treatment and there were four participants (see Table 1). A 2 x2 (treatment type x verb type) framework was used where one participant in each treatment group was trained on irregular verbs (AP2 and AP3), while the other participant was trained on regular verbs (AP6 and AP1).

Procedure

Each treatment session began with 20 treatment probes (picture descriptions of training verbs eliciting three tenses: past, present and future). The following steps were repeated for each treatment verb in ***morphophonological*** treatment: verb naming, auditory same-different discrimination (*kicks-kicked*), lexical decision (*kicks, kickly, digged*, etc.), morphology generation (generate all possible inflectional variants of the given verb stem, e.g., *sink, will sink, sinks, is sinking, sank*), oral and written transformation following a model (*call>>called; ask>>??*), and repetition of all inflectional variants (auxiliaries were included).

Morphosemantic treatment included the following steps: verb naming, anomaly judgment (*Yesterday he will dig a hole*), comprehension (auditory sentence-picture matching), written sentence completion to match a picture (*The man ______ a hole*), and sentence construction using anagrams.

Data Analysis

Accuracy scores were used to compute an effect size using Busk & Serlin's (1992) formula. Narrative speech was also transcribed and coded for lexical and morphosyntactic measures. Inter-rater reliability was obtained for 30% of randomly selected dependent measure samples (scoring of treatment and generalization probes, and narrative analysis).

Results

The treatment and generalization probe accuracy data are presented in Figure 1 and pre-post-treatment test scores with effect sizes are given in Table 1. The most notable aspect of the findings is that participants who received morphosemantic treatment made (AP1, AP3) considerable gains on all measures, while participants who received morphophonological treatment failed to improve even marginally (AP2, AP6). Similar findings were observed for the narrative data on measures of verb morphology.

Study 2

The objective of this study was to compare the relative efficiency of training regular or irregular verbs, while generalization to both verb types was assessed. All participants in this study received *morphosemantic* treatment. The treatment and data analysis procedures are identical to those described for Study 1. Three participants have been tested and two are ongoing.

Results

As shown in Table 1 and Figure 2, participants receiving treatments of both regular and irregular verbs successfully acquired trained verb tenses and generalized to untrained verbs within and across verb type, as is evident by the large effect sizes. A comparison of effect size as a factor of trained verb type failed to reveal any consistent trend.

General Discussion

This paper presents two novel investigations of verb morphology treatment for agrammatism. The findings from the two studies indicate that: 1) treatment of verb morphology is likely to make significant changes in sentence production if associations between the type of tense and the verb form are emphasized (as in the morphosemantic treatment), and 2) training of morphological operations without reference to the tense information (as in morphophonological treatment) is ineffective, at least for agrammatic participants without any accompanying post-lexical phonological deficits, and 3) training of regular or irregular verbs produces comparable treatment and generalization effects, at least for the participants tested so far. These results provide support to theoretical accounts of agramamtism that attribute difficulty with semantically relevant aspects of verb inflections (Burchert et al., 2005; Faroqi-Shah & Thompson, 2007; Wenzlaff & Clahsen, 2004).

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Table 1. Individual pre- and post-treatment scores and corresponding effect sizes for trained verbs (all three tenses combined), untrained verbs (past tense only), and the Aphasia Quotient of the Western Aphasia Battery (WAB AQ). Baseline variability for effect size calculations was 13.4 for the trained and untrained verbs and 11. 4 for the WAB AQ. MP = morphophonological; MS= morphosemantic.

Participant	**Treatment type**	**Verb type**	**Trained verb tense** Effect size (Score difference)	**Untrained Irreg. past** Effect size (Score difference)	**Untrained reg. past** Effect size (Score difference)	**WAB (AQ)** Effect size (Score differenc
STUDY 1						
AP2	MP	Irreg	0.2 (15-11.8)	0.2 (15-11.8)	0.2 (15-11.8)	0.98 (76.6-65.4)
AP6	MP	Reg	0.65 (10-1.25)	0.1 (0-1.25)	0.2 (15-11.8)	0.62 (67.6-60.5)
AP1	MS	Reg	5.86 (100-21.4)	5.86 (100-21.4)	2.88 (60-21.4)	0.4 (71.4-65.9)
AP3	MS	Irreg	7.44 (100-0.25)	4.9 (67-0.25)	4.4 (60.0.25)	0.58 (72.6-65.9)
STUDY 2						
AP10	MS	Reg	5.41 (100-27.5)	5.41 (100-27.5)	5.41 (100-27.5)	1.8 (92.1-77.4)
AP14	MS	Reg	7.4 (100-0.8)	4.4 (60-0.8)	7.02 (95-0.8)	2.6 (75.8-45.6)
AP15	MS	Irreg	5.5 (100-26.3)	3.26 (70-26.3)	5.12 (95-26.3)	1.1 (93.7-80.5)
AP17	MS	Irreg	ongoing			
AP18	MS	Reg	ongoing			

Figure 1. Acquisition and generalization patterns of the four participants in Study 1 in response to morphophonological (top panel) and morphosemantic (lower panel) treatments. B= baseline, T =treatment, F =follow-up.

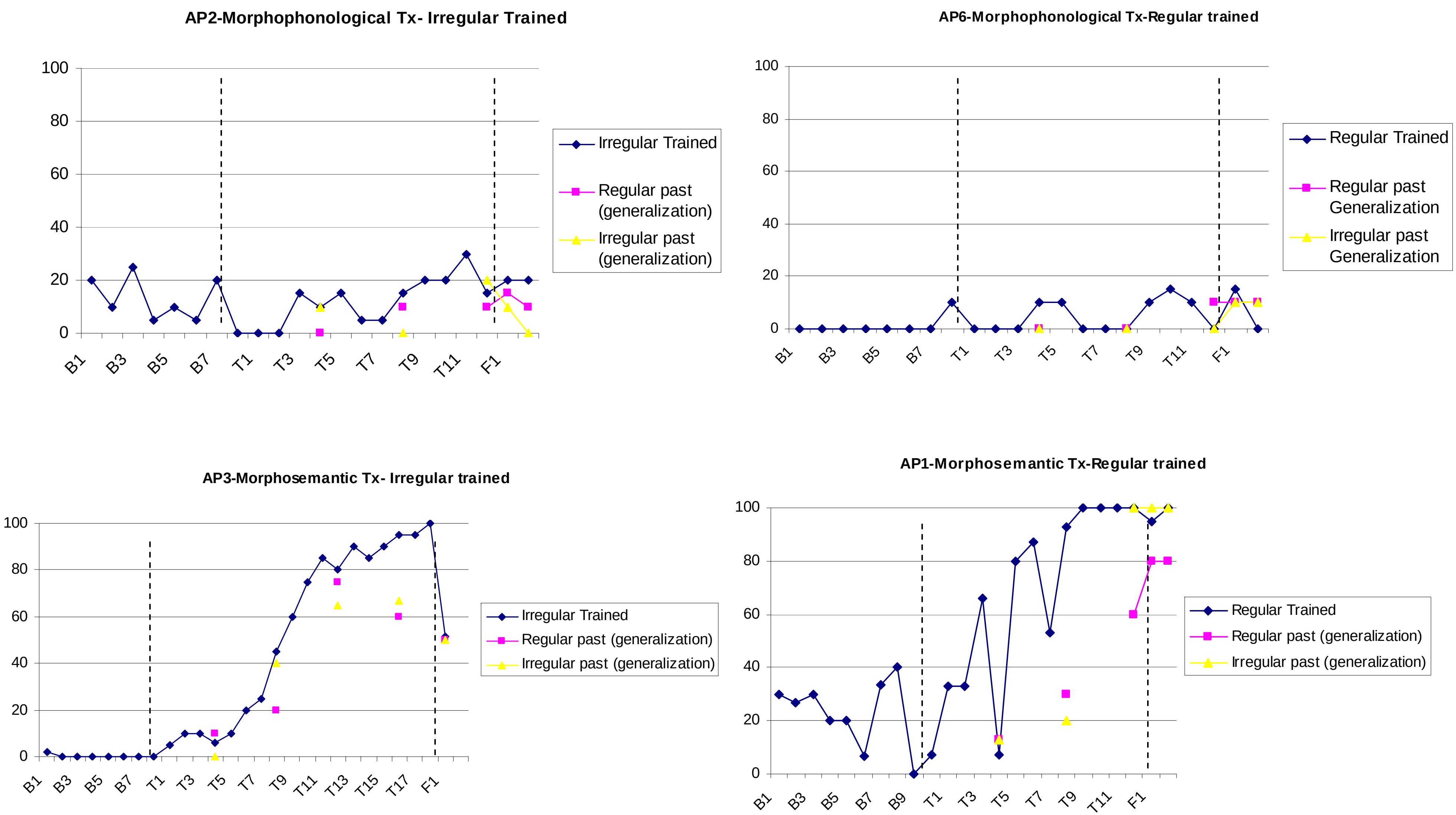

Figure 2. Acquisition and generalization patterns in Study 2 in response to irregular (left panel) and regular (right panel) verb treatments. B= baseline, T =treatment, F =follow-up.