A Novel Approach for the Analysis of Treatment Effects and Training Schedules in Acquired Dysgraphia
Jennifer Shea, Robert Wiley, Gali Ellenblum, Donna Gotsch and Brenda Rapp
Department of Cognitive Science, Johns Hopkins University
http://www.cogsci.jhu.edu

INTRODUCTION
Training schedules impact learning
- Research on learning and memory indicates that studied material is remembered longer when the same amount of study is distributed across multiple sessions rather than being concentrated.
- We examined the effectiveness of a distributed compared to a clustered schedule with treatment delivery in the context of acquired dysgraphia, considering also:
  - Selectivity of the training effects to spelling compared to other cognitive skills
  - Generalization to untrained items
  - Maintenance of learning after 3 months follow-up

Linear Mixed Effects Analysis (L MEM) as an analysis approach
- Studies with single participants or small N groups, pose various challenges to statistical analysis in treatment research.
- However, advances in statistical methods have led to a renewed interest in alternatives to visual analysis
- Multilevel models are a well-established statistical method only recently been examined for applicability to treatment research
- We use the multiple regression approach of generalized Linear Mixed Effects Models (L MEMs) to evaluate the effectiveness of training.
- L MEMs can:
  1. Model the main effects of treatment while controlling for variables like word length and frequency
  2. Address problems in repeated measures designs such as uneven spacing of measurements
  3. Take into account random variability in both items and participants

METHODS
Study Phases
- The study was divided into three phases:
  1. Pre-training evaluation
  2. Spelling training, 2x/week for 12 weeks
  3. Post-training evaluation
- Training Protocol
  - Spell-study-spell technique (Besson 1999, Rapp & Kane 2002) was administered for approx. 90 minutes, 2x/week for 12 weeks. Accuracy and RT for each word were collected at each training time point.
  - 40 training words were selected individually for each participant such that baseline letter accuracy on each word was between 25%-85%.
  - Generalization was evaluated on words (N=164-240) from a variety of spelling lists with words that varied in length and frequency.
- Training words were presented in either a distributed or clustered fashion. Total number of repetitions was the same for all trained words.

DATA ANALYSIS
- For modeling the training data, only the first repetition of a word within a session was included for clustered items.
- L MEMs predict each individual trial, not aggregated data; approximately 200 data points per participant
- Predictor variables were included to evaluate the main effects of session number, training schedule (distributed, clustered) word type (generalization, training), and interactions between these predictors
- Covariates were included controlling for word length, frequency, and days since last practicing that word
- The maximal random effects structure was identified for each model including crossed random effects for items (intercept only) and participant (intercept and correlated slopes)
- Effect size reported as the change in odds ratio

RESULTS
Overall training effectiveness and selectivity
- All individual participants showed improvement
- Improvement in accuracy was greater in training than at post (p = 0.145) and clustered is marginally lower (p = 0.052). Accuracy decrease lower than at post (p = 0.145) and clustered is numerically lower than at post (p = 0.145) and clustered is marginally lower (p = 0.052).

Training Schedule
- Clustered and distributed both showed significant accuracy increases and RT decreases across training sessions

ACKNOWLEDGMENTS
The research reported here was part of a larger, multi-site NIH-funded PS0 project examining the neurobiology of language recovery in people with aphasia (DC012283). We thank DTE, RIN, KST, MDS, and PQS for their effort as participants in this study. We acknowledge Melissa Greenberger, Alexandra Gordon, Tinme Wu and Abigail Lo for their contributions to this project.